```
% begin recording
diary on
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\mbox{\ensuremath{\mbox{\$}}} transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% CONFIG
fname='inpfiles/CM-144-1sta_ele_include.csv'; % file with station, elevation, include
                                            % third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup. H0=7.5548; % significant wave height at toe of structure
Tp=9.9345;
               % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=1;
                  % this may get changed automatically below
gamma_rough=1;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
              ______
SWEL=SWEL+setupAtToe
SWEL =
                     8.736223
SWEL_fore=SWEL+maxSetup
SWEL fore =
                   10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
T<sub>1</sub>O =
           417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
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% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                  -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                  20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))</pre>
                                               % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
       ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1))) %
toe_sta=interpl(dep(kk:kk+1),sta(kk:kk+1),Ztoe)</pre>
                                                       % here is the intersection of Ztoe with profile
    i f
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe sta
toe_sta =
         -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(\overline{dd}<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
```

```
dsetup=maxSetup-setupAtToe;
    dsetdsta=dsetup/dsta;
    setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*HO is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
    sprintf('-!!-
                           setup is adjusted to %4.2f feet', setup)
    SWEL=SWEL-setupAtToe+setup;
    sprintf('-!!-
                           SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
    sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1 sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n') sprintf('-!!- 1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
    sprintf('-!!-
                       2) Reducing the incident wave height to a depth limited condition. \n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
             setup is adjusted to 0.45 feet
-!!-
ans =
-!!-
             SWEL is adjusted to 9.26 feet
k =
      1
      2
      3
      4
      5
      6
7
     24
     25
     26
     27
     28
     29
     30
     31
     32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
sprintf ('!------ STARTING ITERATION %d -----!',iter)
     % elevation of toe of slope
     Ztoe
     % station of toe slope (relative to 0-NAVD88 shoreline
     toe_sta
     % station of top of slope/extent of 2% run-up
     % elevation of top of slope/extent of 2% run-up
     Z2
     % incident significant wave height
    H0
     % incident spectral peak wave period
     Тp
     % incident spectral mean wave period
    T0
     R2=R2_new
     Z2=R2+SWEL
```

```
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                             % here is the intersection of z2 with profile
      \verb"top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)"
     break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% get the length of the slope (not accounting for berm)
Lslope=top sta-toe sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                      % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm width=berm width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm = 0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma perm
gamma beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
   sprintf('!!! - Tribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - <math>!!!\n', Irb*gamma_1
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW VALID=0;
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
```

```
if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    if (Irb*gamma_berm < 1.8)</pre>
       R2\_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore if berm_width > 0.25 * {\tt L0};
       disp ('! Berm_width is greater than 1/4 wave length')
       disp ('!
                  Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
       -----! STARTING ITERATION 1 -----!
Zt.oe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
7.2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
```

```
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 1, Profile Segment: 12
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
        0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma_perm =
gamma beta =
gamma\_rough =
gamma =
        0.977861924974634
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         23.4035594084022
R2del =
        0.739159408402184
Z2 =
          32.659493910529
ans =
!----- STARTING ITERATION 2 -----!
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         112.060463877013
Z2 =
```

```
32.659493910529
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.4035594084022
7.2 =
           32.659493910529
top_sta =
          112.060463877013
Lslope =
          150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
      -- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    17
rB =
         0.113000502776195
rdh_mean =
         0.810625187975784
gamma_berm =
         0.978600551028116
slope =
         0.264201087385079
Irb =
          1.96370840192932
gamma_berm =
         0.978600551028116
gamma_perm =
gamma_beta =
gamma_rough =
gamma =
         0.978600551028116
!!! - - Iribaren number:
                          1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
```

ans =

```
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
         23.3491540099791
R2del =
       0.0544053984230999
Z_{2} =
         32.6050885121059
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         111.691012577114
Z2 =
          32.6050885121059
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
          23.3491540099791
Z2 =
         32.6050885121059
top_sta =
         111.691012577114
Lslope =
         150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.113278689801551
rdh_mean =
        0.810625187975784
gamma_berm =
        0.978547869412482
slope =
```

```
0.264525753135745
Irb =
         1.96612152168106
gamma_berm =
         0.978547869412482
gamma_perm =
gamma_beta =
gamma_rough =
gamma =
         0.978547869412482
ans =
!!! - - Iribaren number: 1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
         23.3530785745975
R2del =
      0.00392456461842983
          32.6090130767243
% final 2% runup elevation
Z2=R2_new+SWEL
          32.6090130767243
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
          417.357062285715
7toe =
                 -2.595977
Z_{2} =
                 20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
         34.9443976794092
toe_sta =
         -38.3813446313046
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     1
     3
     4
     5
     6
    24
    25
    26
27
    28
    29
    30
    31
    32
ans =
       -----! STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
```

```
9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Trb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma perm =
gamma_beta =
gamma_rough =
gamma =
         0.977861924974634
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          23.4035594084022
R2del =
         0.739159408402184
z2 =
```

```
32.659493910529
ans =
      ----- STARTING ITERATION 2 -----!
7toe =
                 -2.595977
toe_sta =
        -38.3813446313046
top_sta =
          112.060463877013
7.2 =
           32.659493910529
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.4035594084022
Z2 =
           32.659493910529
top_sta =
         112.060463877013
Lslope =
          150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
         9.49194100212682
rdh sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
rB =
        0.113000502776195
rdh_mean =
         0.810625187975784
gamma_berm
         0.978600551028116
slope =
         0.264201087385079
Irb =
         1.96370840192932
        0.978600551028116
```

gamma_perm =

```
gamma_beta =
gamma_rough =
gamma =
         0.978600551028116
ans =
!!! - - Iribaren number: 1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
          23.3491540099791
R2del =
        0.0544053984230999
Z2 =
          32.6050885121059
       -----! STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          111.691012577114
          32.6050885121059
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.3491540099791
Z_{2} =
          32.6050885121059
top_sta =
          111.691012577114
Lslope =
          150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 3, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
```

```
!---- End Berm Factor Calculation, Iter: 3 -----!
berm width =
    17
rB =
          0.113278689801551
rdh_mean =
          0.810625187975784
gamma berm =
          0.978547869412482
slope =
          0.264525753135745
Irb =
          1.96612152168106
gamma_berm =
         0.978547869412482
gamma_perm =
gamma_beta =
gamma rough =
gamma =
          0.978547869412482
!!! - - Iribaren number: 1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           23.3530785745975
R2del =
       0.00392456461842983
Z2 =
           32.6090130767243
Z2 =
           32.6090130767243
diary on % begin recording % FEMA appeal for The Town of Harpswell, Cumberland county, Maine % TRANSECT ID: CM-144-1
diary on
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\ensuremath{\mathtt{\$}} transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% CONFIG
fname='inpfiles/CM-144-1sta_ele_include.csv'; % file with station, elevation, include
                                         % third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup. H0=7.5548; % significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
                 % this may get changed automatically below
gamma_berm=1;
gamma_rough=1;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  10.255623
```

```
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
T<sub>1</sub>O =
           417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
\mbox{\ensuremath{\upsigma}} The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                  -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;
              % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
                  20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                 % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
                                                         % here is the intersection of Ztoe with profile
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
    if
       toe_sta=interpl(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe sta
toe_sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                        setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                         SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n') sprintf('-!!- 1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Z
                    1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-
                     2) Reducing the incident wave height to a depth limited condition.\n')
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
```

```
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
\overline{\text{while}}(abs(R2del) > tol \&\& iter <= 25)
    iter=iter+1;
    sprintf ('!-----' STARTING ITERATION %d -----!',iter)
    % elevation of toe of slope
    7.toe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    top sta
    % elevation of top of slope/extent of 2% run-up
    7.2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Тр
    % incident spectral mean wave period
    T0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                 % here is the intersection of z2 with profile
          top_sta=interpl(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end
    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
                          \mbox{\ensuremath{\$}} count it as a berm if slope is flatter than 1:15 (see TAW manual)
       if (s < 1/15)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta; % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if dh < 0
              chi=R2;
          else
              chi=2* H0;
          end
          if (dh <= R2 \& dh >= -2*H0)
             rdh=(0.5-0.5*cos(3.14159*dh/chi));
```

```
else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      {\tt Berm\_Heights=[Berm\_Heights, (dep(kk)+dep(kk+1))/2];}
   end
   if dep(kk) >= 22 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma perm
gamma beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
  TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
  TAW_ALWAYS_VALID=0;
if (Irb*gamma_berm < 1.8)
  R2_new=gamma*H0*1.77*Irb
else
  R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!
             Berm_width is greater than 1/4 wave length')
   disp ('!
              Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm_width >= L0
      R2_new=fore_R2
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
```

```
w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                 % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    topStaAll(iter)=top_sta;
end
ans =
         -----! STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 1, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
```

```
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
        0.810625187975784
gamma_berm =
        0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
gamma =
        0.977861924974634
ans =
!!! - - Iribaren number:
                         1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         23.4035594084022
R2del =
        0.739159408402184
Z_{2} =
           32.659493910529
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         112.060463877013
Z2 =
           32.659493910529
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.4035594084022
Z2 =
          32.659493910529
top_sta =
         112.060463877013
Lslope =
         150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
```

```
10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
rB =
         0.113000502776195
rdh_mean =
        0.810625187975784
gamma berm =
        0.978600551028116
slope =
        0.264201087385079
Irb =
         1.96370840192932
gamma_berm =
        0.978600551028116
gamma\_perm =
gamma_beta =
gamma_rough =
    1
gamma =
        0.978600551028116
ans =
!!! - - Iribaren number: 1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         23.3491540099791
R2del =
        0.0544053984230999
Z2 =
          32.6050885121059
ans =
    -----: STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         111.691012577114
Z2 =
          32.6050885121059
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
          23.3491540099791
Z_{2} =
          32.6050885121059
top_sta =
         111.691012577114
Lslope =
         150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
         9.64669100212682
rdh_sum =
```

```
1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    17
rB =
         0.113278689801551
rdh_mean =
         0.810625187975784
gamma_berm
         0.978547869412482
slope =
         0.264525753135745
Irb =
          1.96612152168106
gamma_berm =
         0.978547869412482
gamma_perm =
gamma_beta =
gamma_rough =
    1
gamma =
         0.978547869412482
ans =
!!! - - Iribaren number: 1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          23.3530785745975
R2del =
       0.00392456461842983
Z2 =
          32.6090130767243
% final 2% runup elevation
Z2=R2\_new+SWEL
Z_{2} =
          32.6090130767243
diary off
diary on
                 % begin recording
\mbox{\ensuremath{\mbox{\tt FEMA}}} appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
\mbox{\ensuremath{\$}} the script does not attempt to apply a depth limit or any other
```

```
% transformation to the incident wave conditions other than
\mbox{\ensuremath{\$}} conversion of the peak wave period to the spectral mean wave
\mbox{\ensuremath{\mbox{\$}}} as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% CONFIG
% third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup. H0=7.5548; % significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
               % this may get changed automatically below
gamma_berm=1;
gamma_rough=1;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                  8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                 10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
\theta_0 %Hb=H0/(3.3*(H0/L0)^(1/3)) %Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                 -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep_org=dep;
\mbox{\%} initial guess at maximum run-up elevation to estimate slope \mbox{\sc Z2=SWEL+1.5*H0}
7.2 =
                 20.068423
% determine station at the max runup and -1.5*HO (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 \le dep(kk+1)))
                                                % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
                                                     % here is the intersection of Ztoe with profile
    if
       ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
```

```
toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dv=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
           34.9443976794092
toe_sta
toe_sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                          setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                         SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is 4.2f feet above the elevation of SWEL-1.5H0\n', dep(1)
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
sprintf('-!!- 1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
sprintf('-!!- 2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
- ! ! -
            setup is adjusted to 0.45 feet
ans =
-11-
            SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
    24
    25
    26
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2 new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!-----: STARTING ITERATION %d -----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    НΟ
    % incident spectral peak wave period
    Тр
      incident spectral mean wave period
    T0
```

```
R2=R2 new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                               % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                       % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk) berm_width=berm_width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!!
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
```

```
end
    if TAW VALID == 0
       TAW_ALWAYS_VALID=0;
    end
    if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb</pre>
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('! disp ('!
                  Berm_width is greater than 1/4 wave length')
                  Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for \overline{k}=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore toe sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2 new=fore R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    topStaAll(iter)=top_sta;
end
ans =
!----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
7.2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
Berm Factor Calculation: Iteration 1, Profile Segment: 9
```

```
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
        0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma_perm =
gamma_beta =
    1
gamma_rough =
    1
gamma =
        0.977861924974634
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         23.4035594084022
R2del =
        0.739159408402184
7.2 =
          32.659493910529
ans =
    -----! STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         112.060463877013
Z2 =
          32.659493910529
```

```
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.4035594084022
Z_{2} =
           32.659493910529
top_sta =
          112.060463877013
Lslope =
          150.441808508318
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 2, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
         11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
         0.113000502776195
rdh_mean =
         0.810625187975784
gamma_berm =
         0.978600551028116
slope =
         0.264201087385079
Irb =
         1.96370840192932
gamma_berm =
         0.978600551028116
gamma_perm =
gamma_beta =
gamma_rough =
gamma =
         0.978600551028116
!!! - - Iribaren number: 1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
```

```
R2\_new =
         23.3491540099791
R2del =
       0.0544053984230999
7.2 =
         32.6050885121059
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         111.691012577114
Z2 =
          32.6050885121059
H0 =
                   7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          23.3491540099791
Z2 =
          32.6050885121059
top_sta =
         111.691012577114
Lslope =
         150.072357208419
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
         10.1985265021268
rdh_sum =
          2.90420535902459
Berm Factor Calculation: Iteration 3, Profile Segment: 13
         10.4744445021268
rdh_sum =
          3.68942949541434
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.113278689801551
rdh_mean =
         0.810625187975784
gamma_berm
        0.978547869412482
slope =
        0.264525753135745
```

```
Irb =
          1.96612152168106
gamma_berm =
         0.978547869412482
gamma_perm =
gamma_beta =
     1
gamma_rough =
     1
gamma =
         0.978547869412482
ans =
!!! - - Iribaren number: 1.92 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2 \text{ new} =
          23.3530785745975
R2del =
       0.00392456461842983
Z2 =
          32.6090130767243
% final 2% runup elevation
Z2=R2_new+SWEL
          32.6090130767243
diary off
diary on
                  % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020 % 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
\ensuremath{^{\circ}} This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
\mbox{\ensuremath{\upsigma}} appropriate values located at the end of the foreshore
\mbox{\%} or toe of the slope on which the run-up is being calculated
\mbox{\ensuremath{\$}} the script does not attempt to apply a depth limit or any other
\ensuremath{\mathtt{\$}} transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
fname='inpfiles/CM-144-1sta_ele_include.csv'; % file with station, elevation, include
                                         % third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
              % significant wave height at toe of structure % peak period, 1/fma,
H0=7.5548;
Tp=9.9345;
\bar{\text{T0}} = \text{Tp}/1.1;
gamma_berm=0.97855; % this may get changed automatically below
gamma rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                   8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
```

```
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                              -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;
                       % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
                              20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
       if ((Z2 > dep(kk))) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
             top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
              ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                                                            % here is the intersection of Ztoe with profile
             toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
       end
end
toe_sta =
               -62.4868075374234
toe_sta =
                -38.3813446313046
top_sta =
                 34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
     dy=dep(1)-Ztoe;
     toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
     dy=Z2-dep(end);
     top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta =
                 34.9443976794092
toe sta
toe_sta =
                -38.3813446313046
\mbox{\ensuremath{\$}} check for case where the toe of slope is below SWL-1.5*H0
  in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
     dd=SWEL_fore-dep;
     k=find(dd<0,1); % k is index of first land point
     staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
     dsta=staAtSWL-sta(1);
     dsetup=maxSetup-setupAtToe;
     dsetdsta=dsetup/dsta;
     setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
     sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
     sprintf('-!!-
                                        setup is adjusted to %4.2f feet', setup)
     SWEL=SWEL-setupAtToe+setup;
     sprintf('-!!-
                                         SWEL is adjusted to %4.2f feet', SWEL)
     k=find(dep < SWEL-1.5*H0)
     sta(k)=[];
     dep(k)=[];
else
     sprintf('-!!-The User has selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) are the selected as th
     sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n') sprintf('-!!- 1) Selecting a starting point that is at or below \%4.2f feet elevation, or\n', Ztoe)
     sprintf('-!!-
                                  2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
                    setup is adjusted to 0.45 feet
-!!-
ans =
-!!-
                    SWEL is adjusted to 9.26 feet
k =
```

2

```
3
     4
     5
     6
7
    24
25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=\overline{0};
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
\overline{\text{while}}(abs(\overline{\text{R2del}}) > \text{tol \&\& iter} <= 25)
    iter=iter+1;
                      -----!',iter
    sprintf ('!--
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe sta
    % station of top of slope/extent of 2% run-up
    top sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    HΩ
    % incident spectral peak wave period
    Тр
    % incident spectral mean wave period
    т0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                   % here is the intersection of z2 with profile
           top_sta=interpl(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm width=0;
    rdh_sum=0;
Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
                            % count it as a berm if slope is flatter than 1:15 (see TAW manual)
       if (s < 1/15)
           sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta; % tally the width of all berm segments % compute the rdh for this segment and weight it by the segment length
           dh=SWEL-(dep(kk)+dep(kk+1))/2
           if dh < 0
               chi=R2;
           else
               chi=2* H0;
           end
           if (dh \le R2 \& dh \ge -2*H0)
              rdh=(0.5-0.5*cos(3.14159*dh/chi));
           else
              rdh=1;
           end
           rdh_sum=rdh_sum + rdh * dsta
           Berm_Segs=[Berm_Segs, kk];
           Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
       if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
```

```
break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma perm
gamma_beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW VALID=1;
if (Irb*gamma berm < 0.5 | Irb*gamma berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
if (Irb*gamma_berm < 1.8)</pre>
   R2_new=gamma*H0*1.77*Irb
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('! disp ('!
              Berm_width is greater than 1/4 wave length')
              Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm_width >= L0
      R2_new=fore_R2
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
      w2=(berm_width-0.25*L0)/(0.75*L0)
      w1 = 1 - w2
      R2_new=w2*fore_R2 + w1*R2_new
end % end berm width check
% convergence criterion
R2del=abs(R2-R2_new)
R2_all(iter)=R2_new;
```

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% get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
         break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
!----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
         145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
```

```
17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
       -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
          10.4744445021268
rdh_sum =
          3.68942949541434
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
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```
10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
        0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
gamma\_rough =
                       0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z2 =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
         23.8523348555397
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
```

```
9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
        0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm =
        0.963939312073811
slope =
        0.365932410915933
Irb =
         2.71983948652912
gamma_berm =
        0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                      0.6
gamma =
        0.578363587244287
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2 new =
          14.549424968147
R2del =
       0.0469753852659309
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
         23.8053594702738
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
          14.549424968147
Z2 =
         23.8053594702738
top_sta =
```

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50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
   \frac{-}{17}
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma berm =
         0.963805449235703
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
```

```
23.8092710365979
diary off
diary on
                  % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\ensuremath{\mathtt{\$}} transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% CONFIG
% third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup. H0=7.5548; % significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
                   8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
% That m (% 1.5.15),

%Hb=H0/(3.3*(H0/L0)^(1/3))

%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average % structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
\mbox{\ensuremath{\$}} to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                  -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
                  20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
```

if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile

```
top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                        % here is the intersection of Ztoe with profile
    if
       toe_sta=interpl(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
          -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe sta
toe_sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup % also un-include points seaward of SWL-1.5*HO
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k = \texttt{find}(\texttt{dd} < \texttt{0,1}); \ \ k \ \ \texttt{is index of first land point}
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                        setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                        SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
   sprintf('-!!-
                    1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-
                     2) Reducing the incident wave height to a depth limited condition.\n')
end
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
            setup is adjusted to 0.45 feet
ans =
-!!-
            SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
7
    2.4
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
```

```
iter=iter+1;
sprintf ('!-----!',iter)
% elevation of toe of slope
7.toe
% station of toe slope (relative to 0-NAVD88 shoreline
toe sta
% station of top of slope/extent of 2% run-up
top sta
% elevation of top of slope/extent of 2% run-up
7.2
% incident significant wave height
H0
% incident spectral peak wave period
Тp
% incident spectral mean wave period
T0
R2=R2_new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                            % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                      \mbox{\ensuremath{\$}} count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 \& dh >= -2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
        rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
     break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
  rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
```

```
gamma rough
    gamma=gamma berm*gamma perm*gamma beta*gamma rough
    % check validity
    TAW_VALID=1;
    if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
       sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
       TAW_VALID=0;
    else
       sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
    end
    islope=1/slope;
    if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                      - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
       TAW_VALID=0;
       sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
    end
    if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    if (Irb*gamma_berm < 1.8)
       R2_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
       disp ('!
                  Berm_width is greater than 1/4 wave length')
       disp ('!
                  Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
   R2del=abs(R2-R2_new)
   R2_all(iter)=R2_new;
   % get the new top station (for plot purposes) Z2=R2\_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                 % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
ans =
         -----: STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
```

end

20.068423

```
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 1, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
         11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.8
gamma =
         0.782289539979707
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
```

```
R2\_new =
          18.7228475267218
R2del =
          3.94155247327825
7.2 =
          27.9787820288486
top_sta =
          79.8990878658385
ans =
       -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          79.8990878658385
Z_{2} =
          27.9787820288486
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          18.7228475267218
z2 =
          27.9787820288486
top_sta =
          79.8990878658385
Lslope =
          118.280432497143
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 2, Profile Segment: 12
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
rB =
         0.143726224541922
rdh_mean =
         0.810625187975784
gamma_berm =
         0.972781873244423
```

```
slope =
         0.301882192591457
Irb =
          2.24377803987103
gamma_berm =
         0.972781873244423
gamma_perm =
gamma_beta =
gamma_rough =
                       0.8
gamma =
         0.778225498595539
ans =
!!! - - Iribaren number: 2.18 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          19.0011704443444
R2del =
          0.27832291762261
Z2 =
          28.2571049464712
top_sta =
          81.8553611847108
ans =
              ---- STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          81.8553611847108
Z2 =
          28.2571049464712
H0 =
                    7.5548
= qT
                    9.9345
T0 =
          9.03136363636364
R2 =
          19.0011704443444
Z2 =
          28.2571049464712
top_sta =
          81.8553611847108
Lslope =
          120.236705816015
Berm Factor Calculation: Iteration 3, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
          11.0262795021268
```

```
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
          0.14138777243293
rdh_mean =
        0.810625187975784
gamma_berm
        0.973224717172991
slope =
        0.298857675693918
Irb =
          2.22129793086672
gamma_berm =
         0.973224717172991
gamma_perm =
gamma\_beta =
gamma_rough =
                       0.8
gamma =
        0.778579773738393
ans =
!!! - - Iribaren number: 2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         18.9781084739222
R2del =
        0.0230619704221695
7.2 =
           28.234042976049
top_sta =
         81.6932634393908
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
          81.6932634393908
Z2 =
           28.234042976049
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
         18.9781084739222
Z2 =
          28.234042976049
top_sta =
          81.6932634393908
Lslope =
         120.074608070695
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
          10.1985265021268
```

```
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
   17
rB =
         0.141578642421977
rdh_mean =
         0.810625187975784
gamma_berm =
         0.973188571204694
slope =
         0.299103926302623
Irb =
          2.22312822003805
gamma berm =
         0.973188571204694
gamma_perm =
gamma_beta =
gamma_rough =
                       0.8
gamma =
         0.778550856963756
!!! - - Iribaren number: 2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
         18.9800034263996
R2del =
        0.0018949524774321
          28.2359379285264
top_sta =
          81.7065826622698
% final 2% runup elevation
Z2=R2_new+SWEL
28.2359379285264
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
          417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
         -62.4868075374234
         -38.3813446313046
top_sta =
         34.9443976794092
top_sta =
         34.9443976794092
        -38.3813446313046
ans =
```

```
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
           setup is adjusted to 0.45 feet
-!!-
ans =
           SWEL is adjusted to 9.26 feet
-!!-
k =
     1
     3
     4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
         -----: STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
72 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 1, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 1, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
```

```
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
         0.977861924974634
slope =
         0.268771755517362
Irb =
         1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.8
gamma =
         0.782289539979707
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         18.7228475267218
R2del =
          3.94155247327825
Z_{2} =
          27.9787820288486
top_sta =
         79.8990878658385
ans =
      -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         79.8990878658385
Z2 =
          27.9787820288486
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         18.7228475267218
          27.9787820288486
top_sta =
          79.8990878658385
Lslope =
         118.280432497143
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 2, Profile Segment: 12
          10.1985265021268
rdh_sum =
          2.90420535902459
```

```
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
rB =
        0.143726224541922
rdh_mean =
        0.810625187975784
gamma_berm =
        0.972781873244423
slope =
        0.301882192591457
Trb =
         2.24377803987103
gamma_berm =
        0.972781873244423
gamma_perm =
gamma_beta =
gamma_rough =
                       0.8
gamma =
        0.778225498595539
ans =
!!! - - Iribaren number: 2.18 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          19.0011704443444
R2del =
          0.27832291762261
         28.2571049464712
top_sta =
          81.8553611847108
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         81.8553611847108
Z_{2} =
          28.2571049464712
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
          19.0011704443444
7.2 =
          28.2571049464712
top_sta =
          81.8553611847108
Lslope =
          120.236705816015
Berm Factor Calculation: Iteration 3, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
```

```
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
          0.14138777243293
rdh_mean =
         0.810625187975784
gamma_berm
         0.973224717172991
slope =
        0.298857675693918
Irb =
          2.22129793086672
gamma berm =
         0.973224717172991
gamma_perm =
gamma_beta =
gamma_rough =
                       0.8
gamma =
        0.778579773738393
ans =
!!! - - Iribaren number: 2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         18.9781084739222
R2del =
        0.0230619704221695
Z2 =
           28.234042976049
top_sta =
         81.6932634393908
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          81.6932634393908
Z2 =
           28.234042976049
H0 =
                    7.5548
```

```
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          18.9781084739222
7.2 =
           28.234042976049
top_sta =
          81.6932634393908
Lslope =
          120.074608070695
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 4, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.141578642421977
rdh_mean =
         0.810625187975784
gamma_berm =
         0.973188571204694
slope =
         0.299103926302623
Irb =
          2.22312822003805
gamma_berm =
         0.973188571204694
gamma_perm =
gamma_beta =
gamma_rough =
                       0.8
gamma =
         0.778550856963756
!!! - - Iribaren number: 2.16 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          18.9800034263996
```

```
R2del =
       0.0018949524774321
7.2 =
         28.2359379285264
top_sta =
          81.7065826622698
Z2 =
          28.2359379285264
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
          417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     2
     3
4
     5
     6
7
    24
    25
26
    27
    28
    29
    30
    31
    32
ans =
!----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
          9.64669100212682
rdh_sum =
```

```
1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
        0.116900842243663
rdh_mean =
        0.810625187975784
gamma_berm
        0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
```

```
14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
          10.1985265021268
rdh sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.5964003534129
R2del =
         0.554264708371569
          23.8523348555397
top_sta =
```

```
50.8951497883595
ans =
       -----! STARTING ITERATION 3 -----!
7toe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
7.2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
Berm Factor Calculation: Iteration 3, Profile Segment: 9
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
```

```
1
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.549424968147
R2del =
       0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
         50.5649673529656
       -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z_{2} =
         23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
         11.0262795021268
rdh_sum =
         5.32809529031497
Berm Factor Calculation: Iteration 4, Profile Segment: 16
         11.2205850021268
rdh_sum =
```

```
13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
   17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
        0.963805449235703
gamma_perm =
gamma_rough =
                       0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
          23.8092710365979
top_sta =
          50.5924611241776
Z_{2} =
          23.8092710365979
diary on
                % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
\mbox{\ensuremath{\$}} calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
\ensuremath{\mathtt{\$}} This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
Yan der Meer, J.W., 2002. Technical Report Wave Run-up and
Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% CONFIG
% third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
H0=7.5548;
              % significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
```

```
8.736223
SWEL fore=SWEL+maxSetup
SWEL fore =
                  10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
           417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
\mbox{\ensuremath{\$}} The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
\mbox{\ensuremath{\$}} to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
                  -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta org=sta;
              % used for plotting purposes
dep org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                  20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                  % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
                                                        % here is the intersection of Ztoe with profile
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
    if
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
top sta
top_sta =
          34.9443976794092
toe sta
toe_sta =
          -38.3813446313046
\mbox{\ensuremath{\$}} check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                        setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                        SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
                    1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
                    2) Reducing the incident wave height to a depth limited condition.\n')
```

```
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
           setup is adjusted to 0.45 feet
-11-
ans =
           SWEL is adjusted to 9.26 feet
- ! ! -
k =
     1
     2
     3
     4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=\overline{0};
R2 all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!-----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    % elevation of top of slope/extent of 2% run-up
    Z_2
    % incident significant wave height
    Н0
    % incident spectral peak wave period
    Тp
     incident spectral mean wave period
    T0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                  % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end
    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
       if (s < 1/15)
                           % count it as a berm if slope is flatter than 1:15 (see TAW manual)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
          berm_width=berm_width+dsta; % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if dh < 0
              chi=R2;
          else
```

```
chi=2* H0;
      end
      if (dh <= R2 \& dh >= -2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
if (Irb*gamma_berm < 1.8)</pre>
  R2_new=gamma*H0*1.77*Irb
else
  R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
              Berm_width is greater than 1/4 wave length')
Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   disp ('!
   disp ('!
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
```

```
if berm_width >= L0
          R2 new=fore R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 \le dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
       -----! STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z_{2} =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
7.2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
```

```
11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
         0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma_perm =
gamma_beta =
gamma\_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
          8.62226435495869
Z_{2} =
         23.2980701471681
top_sta =
          46.9993332993712
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
          23.2980701471681
H0 =
                   7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.0421356450413
Z2 =
         23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
```

```
10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
         0.554264708371569
Z2 =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
       -----! STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z_{2} =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
```

```
9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
         10.1985265021268
rdh_sum =
         2.90420535902459
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
        0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm
        0.963939312073811
slope =
        0.365932410915933
Irb =
         2.71983948652912
gamma_berm =
        0.963939312073811
gamma_perm =
gamma_beta =
gamma\_rough =
                      0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.549424968147
R2del =
       0.0469753852659309
Z_{2} =
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!----!
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
```

```
23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
7.2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
      -- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578283269541422
!!! - - Iribaren number:
                          2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
```

```
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
           14.553336534471
R2del =
      0.00391156632409739
7.2 =
          23.8092710365979
top_sta =
50.5924611241776
% final 2% runup elevation
Z2=R2\_new+SWEL
23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
          417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
         34.9443976794092
top_sta =
         34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
           SWEL is adjusted to 9.26 feet
- ! ! -
k =
     2
     3
     4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
        ----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh_sum =
```

```
0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
         10.7503620021268
rdh sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
        0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
        0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
72 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
 -----! STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
```

H0 =

```
7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z_{2} =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
      -- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
```

```
14.5964003534129
R2del =
        0.554264708371569
Z2 =
          23.8523348555397
top_sta =
         50.8951497883595
ans =
!-----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
          23.8523348555397
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.5964003534129
         23.8523348555397
top_sta =
         50.8951497883595
Lslope =
         89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm =
        0.963939312073811
slope =
```

```
0.365932410915933
Irb =
         2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
       0.0469753852659309
Z2 =
         23.8053594702738
top_sta =
          50.5649673529656
ans =
      -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
          14.549424968147
Z_{2} =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
Berm Factor Calculation: Iteration 4, Profile Segment: 15
         11.0262795021268
rdh_sum =
```

```
5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
         23.8092710365979
top_sta =
          50.5924611241776
Z_{2} =
          23.8092710365979
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
         417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
         34.9443976794092
top_sta =
         34.9443976794092
toe_sta =
        -38.3813446313046
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-11-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
7
    24
    25
    26
```

```
31
    32
ans =
          ----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
7.2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
Berm Factor Calculation: Iteration 1, Profile Segment: 13
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
```

```
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
                          1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - Iribaren number:
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
Z_{2} =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
       -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z_{2} =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 2, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
          11.2205850021268
```

```
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
      ----- STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z_{2} =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
          10.4744445021268
```

```
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
         2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma\_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
          14.549424968147
R2del =
       0.0469753852659309
         23.8053594702738
top_sta =
         50.5649673529656
ans =
      -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
          14.549424968147
Z_{2} =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
          9.64669100212682
```

```
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number:
                          2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
Z_{2} =
          23.8092710365979
top_sta =
          50.5924611241776
Z_{2} =
          23.8092710365979
diary on
                 % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
\mbox{\ensuremath{\$}} the script does not attempt to apply a depth limit or any other
```

```
% transformation to the incident wave conditions other than
\mbox{\ensuremath{\$}} conversion of the peak wave period to the spectral mean wave
\mbox{\ensuremath{\mbox{\$}}} as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% CONFIG
% third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
H0=7.5548;
              % significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                 10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
\theta_0 %Hb=H0/(3.3*(H0/L0)^(1/3)) %Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                 -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep_org=dep;
\mbox{\%} initial guess at maximum run-up elevation to estimate slope \mbox{\sc Z2=SWEL+1.5*H0}
7.2 =
                 20.068423
% determine station at the max runup and -1.5*HO (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 \le dep(kk+1)))
                                               % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
    end
                                                    % here is the intersection of Ztoe with profile
    if
       ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
         34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
```

```
toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dv=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
           34.9443976794092
toe_sta
toe_sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                          setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                         SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is 4.2f feet above the elevation of SWEL-1.5H0\n', dep(1)
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
sprintf('-!!- 1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
sprintf('-!!- 2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
- ! ! -
            setup is adjusted to 0.45 feet
ans =
-11-
            SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
    24
    25
    26
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2 new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!-----: STARTING ITERATION %d -----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe_sta
    % station of top of slope/extent of 2% run-up
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    НΟ
    % incident spectral peak wave period
    Тр
      incident spectral mean wave period
    T0
```

```
R2=R2 new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                               % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                       % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk) berm_width=berm_width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!!
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
```

```
end
    if TAW VALID == 0
       TAW_ALWAYS_VALID=0;
    end
    if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb</pre>
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
       disp ('! disp ('!
                  Berm_width is greater than 1/4 wave length')
                  Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for \overline{k}=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore toe sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2 new=fore R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    topStaAll(iter)=top_sta;
end
ans =
!----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
7.2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
Berm Factor Calculation: Iteration 1, Profile Segment: 9
```

```
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
7.2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
       -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         46.9993332993712
```

```
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z_{2} =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 2, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
```

```
ans
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
         0.554264708371569
7.2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
     -----! STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 3, Profile Segment: 12
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
```

```
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top sta =
          50.5649673529656
ans =
       -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
           14.549424968147
Z_{2} =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
Berm Factor Calculation: Iteration 4, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 4, Profile Segment: 15
```

```
dh =
          11.0262795021268
rdh_sum =
           5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                         0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
7.2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
          23.8092710365979
diary off
diary on
                  % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\mbox{\ensuremath{\$}} transformation to the incident wave conditions other than
\mbox{\ensuremath{\$}} conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%-----
% CONFIG
fname='inpfiles/CM-144-1sta_ele_include.csv'; % file with station, elevation, include
                                        % third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
H0=7.5548;
               % significant wave height at toe of structure
Tp=9.9345;
               % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
```

```
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                  8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                 10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                 -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
             % used for plotting purposes
sta_org=sta;
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
7.2 =
                 20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                             % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                     % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top sta =
         34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe sta==-999
   dy=dep(1)-Ztoe;
   toe\_sta=sta(1)-dy/S(1)
end
if top sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
         -38.3813446313046
\mbox{\ensuremath{\$}} check for case where the toe of slope is below SWL-1.5*H0
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope', dsta)
```

```
sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                       setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                       SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is 4.2f feet above the elevation of SWEL-1.5H0\n', dep(1)
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n') sprintf('-!!- 1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-
                   2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!--
                    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    % incident significant wave height
    Н0
    % incident spectral peak wave period
    Тp
    % incident spectral mean wave period
    T0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                 % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end
    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
```

```
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                      \mbox{\ensuremath{\$}} count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 & dh >=-2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
  rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
 check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!!
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW VALID=0;
else
  sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW VALID == 0
   TAW_ALWAYS_VALID=0;
end
if (Irb*gamma berm < 1.8)
  R2\_new=gamma*H0*1.77*Irb
else
  R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore if berm_width > 0.25 * {\tt L0};
   disp ('! Berm_width is greater than 1/4 wave length')
   disp ('!
              Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
```

```
end
          fore toe sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
   R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
   Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
      -----! STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
          10.1985265021268
rdh_sum =
          2.90420535902459
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
```

```
10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
rB =
         0.116900842243663
rdh_mean =
        0.810625187975784
gamma_berm =
        0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma\_perm =
gamma_beta =
    1
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
    -----! STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe sta =
         -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
         23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.0421356450413
7.2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
         9.49194100212682
rdh_sum =
        0.695983762046982
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
```

```
9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
         10.4744445021268
rdh_sum =
         3.68942949541434
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
        0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm
         0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z_{2} =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
!-----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
         23.8523348555397
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
```

```
9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Trb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
       0.0469753852659309
Z2 =
```

```
23.8053594702738
top_sta =
          50.5649673529656
ans =
      ----- STARTING ITERATION 4 -----!
!----
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
   17
rB =
         0.191126530383928
rdh_mean =
        0.810625187975784
gamma_berm :
        0.963805449235703
slope =
        0.366958857822288
         2.72746868455436
gamma_berm =
```

```
0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.553336534471
R2del =
       0.00391156632409739
         23.8092710365979
top_sta =
         50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                 8.736223
SWEL_fore =
                10.255623
L0 =
         417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
         -62.4868075374234
toe_sta =
        -38.3813446313046
top_sta =
         34.9443976794092
top_sta =
         34.9443976794092
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
          setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     2
     3
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
!----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
        -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
```

```
22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
          10.1985265021268
rdh sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
```

```
46.9993332993712
ans =
       -----! STARTING ITERATION 2 -----!
7toe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
7.2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
Berm Factor Calculation: Iteration 2, Profile Segment: 9
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
         0.962293906742863
```

gamma_perm =

```
1
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
         50.8951497883595
       -----! STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.5964003534129
Z_{2} =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
         11.0262795021268
rdh_sum =
         5.32809529031497
Berm Factor Calculation: Iteration 3, Profile Segment: 16
         11.2205850021268
rdh_sum =
```

```
13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
        0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm =
         0.963939312073811
slope =
        0.365932410915933
Irb =
          2.71983948652912
gamma\_berm =
        0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
         23.8053594702738
top_sta =
          50.5649673529656
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.5649673529656
7.2 =
          23.8053594702738
H0 =
                   7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
         10.1985265021268
rdh_sum =
         2.90420535902459
Berm Factor Calculation: Iteration 4, Profile Segment: 13
         10.4744445021268
rdh_sum =
```

```
3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
           10.7503620021268
rdh_sum =
           4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
           11.0262795021268
rdh_sum =
           5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
           11.2205850021268
rdh_sum =
          13.7806281955883
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
          0.191126530383928
rdh_mean =
          0.810625187975784
gamma_berm =
          0.963805449235703
slope =
          0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
          0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                          0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
            14.553336534471
R2del =
       0.00391156632409739
Z2 =
           23.8092710365979
top_sta =
           50.5924611241776
Z2 =
          23.8092710365979
diary on
                  % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the % appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\mbox{\ensuremath{\upsigma}} transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
fname='inpfiles/CM-144-1sta_ele_include.csv'; % file with station, elevation, include
```

% third columm is 0 for excluded points

```
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
H0=7.5548;
               \ensuremath{\mathtt{\textit{\$}}} significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                   8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
           417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average % structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
7toe =
                  -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;
              % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                  20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                       % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe sta =
         -62.4868075374234
toe sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
 also un-include points seaward of SWL-1.5*HO
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
```

```
staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                        setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
                        SWEL is adjusted to %4.2f feet', SWEL)
   sprintf('-!!-
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is 4.2f feet above the elevation of SWEL-1.5H0\n', dep(1)
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
   sprintf('-!!-
                    1) Selecting a starting point that is at or below 4.2f feet elevation, or\n', Ztoe)
                    2) Reducing the incident wave height to a depth limited condition. \n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
           setup is adjusted to 0.45 feet
-!!-
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
\overline{\text{while}}(abs(\overline{\text{R2del}}) > \text{tol \&\& iter} <= 25)
    iter=iter+1;
    sprintf ('!------ STARTING ITERATION %d -----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe sta
    % station of top of slope/extent of 2% run-up
    top sta
    % elevation of top of slope/extent of 2% run-up
    Z_2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Тp
    % incident spectral mean wave period
    T0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
                                                   % here is the intersection of z2 with profile
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
```

```
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, \bar{b}erm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
                      % count it as a berm if slope is flatter than 1:15 (see TAW manual)
   if (s < 1/15)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 \& dh >= -2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!!
                 - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end
if (Irb*gamma_berm < 1.8)</pre>
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('! Berm_width is greater than 1/4 wave length')
              Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
```

```
for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
if s < 1/15</pre>
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)</pre>
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes) Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                  % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
         -----: STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                  20.068423
H0 =
                    7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
                    22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
```

```
10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
       -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z_{2} =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
```

```
9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
         10.1985265021268
rdh_sum =
         2.90420535902459
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
        0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm
        0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
gamma\_rough =
                      0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z2 =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
!----!
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
```

```
23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
7.2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
      -- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578363587244287
!!! - - Iribaren number:
                          2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
```

```
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.549424968147
R2del =
       0.0469753852659309
Z_{2} =
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!-----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
         23.8053594702738
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
          14.549424968147
         23.8053594702738
top_sta =
         50.5649673529656
Lslope =
         88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
         11.2205850021268
rdh_sum =
         13.7806281955883
!---- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
rB =
        0.191126530383928
        0.810625187975784
gamma_berm =
```

```
0.963805449235703
slope =
         0.366958857822288
Trb =
          2.72746868455436
gamma_berm = 0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
       0.00391156632409739
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
          23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                 8.736223
SWEL_fore =
                 10.255623
L0 =
          417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
         34.9443976794092
toe_sta =
         -38.3813446313046
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
7
    24
    25
26
    27
    28
    29
    30
    31
    32
ans =
        -----! STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
```

```
7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
      -- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
```

```
14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
!-----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
          23.2980701471681
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.0421356450413
         23.2980701471681
top_sta =
         46.9993332993712
Lslope =
         85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
         0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm =
        0.962293906742863
slope =
```

```
0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
      -----! STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z_{2} =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 3, Profile Segment: 15
         11.0262795021268
rdh_sum =
```

```
5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
        0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm =
         0.963939312073811
slope =
        0.365932410915933
Irb =
         2.71983948652912
gamma_berm =
        0.963939312073811
gamma perm =
gamma_beta =
gamma_rough =
                      0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.549424968147
R2del =
       0.0469753852659309
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
         23.8053594702738
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.549424968147
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
Lslope =
         88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
         9.92260850212682
rdh_sum =
         2.14299703977601
Berm Factor Calculation: Iteration 4, Profile Segment: 12
         10.1985265021268
rdh_sum =
```

```
2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
           10.4744445021268
rdh_sum =
           3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
           4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 4, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                         0.6
gamma =
         0.578283269541422
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
           23.8092710365979
top sta =
          50.5924611241776
z2 =
          23.8092710365979
                  % begin recording
diary on
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
\mbox{\ensuremath{\upsigma}} This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
\mbox{\ensuremath{\$}} or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\ensuremath{\mathtt{\$}} transformation to the incident wave conditions other than
\mbox{\ensuremath{\$}} conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
Yan der Meer, J.W., 2002. Technical Report Wave Run-up and
Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
```

```
% _
% CONFIG
% third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
H0=7.5548;
              % significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                  8.736223
SWEL_fore=SWEL+maxSetup
SWEL fore =
                 10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
% HD=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                 -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
                 20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                 % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                     % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
         34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe sta
toe_sta =
         -38.3813446313046
```

```
% check for case where the toe of slope is below {\tt SWL-1.5*H0}
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);</pre>
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*HO is $4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
   sprintf('-!!-
                        setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                       SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
                    1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-
                    2) Reducing the incident wave height to a depth limited condition. \n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    2.5
    26
    27
    2.8
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2 new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(\overline{R}2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!---
                   -----!',iter
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe sta
    % station of top of slope/extent of 2% run-up
    top sta
    % elevation of top of slope/extent of 2% run-up
    Z_2
    % incident significant wave height
    HΩ
    % incident spectral peak wave period
    Тp
    % incident spectral mean wave period
    T0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                   % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
```

```
top_sta=sta(end)+dy/S(end)
end
% get the length of the slope (not accounting for berm)
Lslope=top sta-toe sta
\$ loop over profile segments to determine berm factor \$ re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                       % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta;
                                     % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 \& dh >= -2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma perm
gamma_beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
sprintf('!!! - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('! Berm_width is greater than 1/4 wave length')
```

```
Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       disp ('!
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes) Z2=R2\_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
ans =
    -----! STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
```

```
9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
        0.116900842243663
rdh_mean =
        0.810625187975784
gamma_berm =
        0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                      0.6
gamma =
         0.58671715498478
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
         8.62226435495869
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
         23.2980701471681
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.0421356450413
Z2 =
         23.2980701471681
top_sta =
```

```
46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   \frac{-}{17}
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
        -----: STARTING ITERATION 3 -----!
Ztoe =
```

```
-2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z_{2} =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
```

```
0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
        0.0469753852659309
Z_{2} =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
```

```
17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
         0.578283269541422
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
          417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
ans =
           ----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
```

```
-38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
          9.64669100212682
rdh sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
```

```
0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
7.2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
       -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
          11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
```

rB =

```
0.199108280843155
rdh_mean =
         0.810625187975784
gamma berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm = 0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.5964003534129
R2del =
         0.554264708371569
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
     -----! STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
72 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z_{2} =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
         10.7503620021268
rdh_sum =
```

```
4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans = !!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
        0.0469753852659309
7.2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
     -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
          9.64669100212682
rdh_sum =
         1.40666398849417
Berm Factor Calculation: Iteration 4, Profile Segment: 11
          9.92260850212682
rdh_sum =
```

```
2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
          11.2205850021268
rdh sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                        0.6
gamma =
         0.578283269541422
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2 \text{ new} =
           14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
7.2 =
          23.8092710365979
diary on
                 % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
\mbox{\%} or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
```

```
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
<u>%______</u>
% CONFIG
% third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
H0=7.5548;
             % significant wave height at toe of structure
Tp=9.9345;
             % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                 8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
                 20.068423
% determine station at the max runup and -1.5*HO (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((22 > dep(kk)) & (22 <= dep(kk+1))) % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
       ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                  % here is the intersection of Ztoe with profile
    i f
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
        -62.4868075374234
toe_sta =
        -38.3813446313046
         34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
```

```
top sta
top_sta =
          34.9443976794092
toe sta
toe_sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0 \,
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup') sprintf('-!!- setup is adjusted to %4.2f feet',setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                        SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is <math>4.2f feet above the elevation of SWEL-1.5H0\n', dep(1)
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
   sprintf('-!!-
                     1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-
                     2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-11-
            setup is adjusted to 0.45 feet
ans =
- ! ! -
            SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=\overline{0};
R2 all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
\overline{\text{while}}(abs(\overline{\text{R2del}}) > \text{tol \&\& iter} <= 25)
    iter=iter+1;
    sprintf ('!-----'.',iter)
    % elevation of toe of slope
    Ztoe
    \mbox{\ensuremath{\$}} station of toe slope (relative to 0-NAVD88 shoreline
    toe sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z_2
    % incident significant wave height
    HΩ
    % incident spectral peak wave period
    Тp
    % incident spectral mean wave period
    T0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
```

```
top sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                       % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
berm_width=berm_width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 \& dh >= -2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
        rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma berm
gamma perm
gamma beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
  TAW VALID=0;
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                  - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
if TAW_VALID == 0
  TAW_ALWAYS_VALID=0;
if (Irb*gamma_berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
```

```
else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * LO;
       disp ('! disp ('!
                  Berm_width is greater than 1/4 wave length')
Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2 new=fore R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 \le dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    topStaAll(iter)=top_sta;
end
ans =
     -----! STARTING ITERATION 1 -----!
Ztoe =
                  -2.595977
toe sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                  20.068423
H0 =
                     7.5548
Tp =
                     9.9345
T0 =
          9.03136363636364
R2 =
                    22.6644
7.2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 1, Profile Segment: 10
```

```
9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
         10.4744445021268
rdh_sum =
         3.68942949541434
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
        0.116900842243663
rdh_mean =
        0.810625187975784
gamma_berm
         0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
        0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                      0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
         8.62226435495869
Z_{2} =
         23.2980701471681
top_sta =
         46.9993332993712
ans =
!-----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
         23.2980701471681
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
```

```
9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Trb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.5964003534129
R2del =
         0.554264708371569
z2 =
```

```
23.8523348555397
top_sta =
          50.8951497883595
ans =
      -----! STARTING ITERATION 3 -----!
!----
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.5964003534129
Z2 =
         23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm :
        0.963939312073811
slope =
        0.365932410915933
         2.71983948652912
gamma_berm =
```

```
0.963939312073811
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
       -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
72 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
```

```
11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
   17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
7.2 =
         23.8092710365979
top\_sta =
50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
          417.357062285715
Ztoe =
                 -2.595977
Z2 =
                 20.068423
toe_sta =
        -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
top_sta =
         34.9443976794092
toe_sta =
        -38.3813446313046
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
           setup is adjusted to 0.45 feet
ans =
           SWEL is adjusted to 9.26 feet
- ! ! -
k =
     1
     2
     3
     4
     5
     6
7
    24
    25
    26
    27
```

30 31

```
32
ans =
         -----: STARTING ITERATION 1 -----!
7toe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
7.2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
         0.977861924974634
gamma_perm =
```

```
1
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
          8.62226435495869
Z2 =
         23.2980701471681
top_sta =
         46.9993332993712
 -----! STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.0421356450413
Z_{2} =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
         11.0262795021268
rdh_sum =
         5.32809529031497
Berm Factor Calculation: Iteration 2, Profile Segment: 16
         11.2205850021268
rdh_sum =
```

```
13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
        0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm =
         0.962293906742863
slope =
        0.378674911258111
Irb =
          2.81454975146854
gamma\_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z2 =
         23.8523348555397
top_sta =
          50.8951497883595
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.8951497883595
7.2 =
          23.8523348555397
H0 =
                   7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
         10.1985265021268
rdh_sum =
         2.90420535902459
Berm Factor Calculation: Iteration 3, Profile Segment: 13
         10.4744445021268
rdh_sum =
```

```
3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
        0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm =
        0.963939312073811
slope =
        0.365932410915933
Irb =
         2.71983948652912
gamma_berm =
        0.963939312073811
gamma_perm =
gamma_beta =
    1
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.549424968147
R2del =
        0.0469753852659309
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
          23.8053594702738
H0 =
                   7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
          14.549424968147
Z_{2} =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
          9.49194100212682
rdh_sum =
        0.695983762046982
Berm Factor Calculation: Iteration 4, Profile Segment: 10
         9.64669100212682
rdh_sum =
```

```
1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
   17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
        0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
        0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.553336534471
R2del =
       0.00391156632409739
Z2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z_{2} =
         23.8092710365979
plotTitle =
Iterative TAW for CM-144-1
SWEL =
                  8.736223
SWEL_fore =
                 10.255623
L0 =
         417.357062285715
Ztoe =
                 -2.595977
                 20.068423
        -62.4868075374234
toe_sta =
```

```
-38.3813446313046
top_sta =
          34.9443976794092
top_sta =
          34.9443976794092
toe_sta =
         -38.3813446313046
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
-!!-
           setup is adjusted to 0.45 feet
ans =
-!!-
           SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
7
    24
    26
    27
    29
    30
    31
    32
ans =
          ----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z_{2} =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
          10.7503620021268
```

```
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
         0.977861924974634
slope =
         0.268771755517362
Irb =
           1.9976804779061
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
ans =
         ----- STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z_{2} =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
          9.92260850212682
```

```
rdh_sum =
         2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
         5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
        0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm =
        0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z2 =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.8951497883595
Z_{2} =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
```

```
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578363587244287
ans =
                          2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - Iribaren number:
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
        0.0469753852659309
Z_{2} =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
          -----: STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
```

```
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
7.2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
7.2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
Berm Factor Calculation: Iteration 4, Profile Segment: 14
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
```

```
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
7.2 =
          23.8092710365979
top_sta =
          50.5924611241776
Z_{2} =
          23.8092710365979
diary on
                 % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
%_____
% CONFIG
fname='inpfiles/CM-144-1sta_ele_include.csv'; % file with station, elevation, include
                                       % third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
H0=7.5548;
              % significant wave height at toe of structure
Tp=9.9345;
              % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                  8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                 10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
                 -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
```

```
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
                              20.068423
% determine station at the max runup and -1.5*HO (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
             top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
       if
             ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                                                            % here is the intersection of Ztoe with profile
             toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
       end
end
toe_sta =
                -62.4868075374234
toe_sta =
                -38.3813446313046
top_sta =
                 34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
     dy=dep(1)-Ztoe;
     toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
     dy=Z2-dep(end);
     top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
                 34.9443976794092
toe sta
toe_sta =
                -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
     dd=SWEL_fore-dep;
     k=find(dd<0,1); % k is index of first land point
     staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
     dsta=staAtSWL-sta(1);
     dsetup=maxSetup-setupAtToe;
     dsetdsta=dsetup/dsta;
     setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
     sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope', dsta)
     sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
     sprintf('-!!-
                                        setup is adjusted to %4.2f feet', setup)
     SWEL=SWEL-setupAtToe+setup;
     sprintf('-!!-
                                        SWEL is adjusted to %4.2f feet', SWEL)
     k=find(dep < SWEL-1.5*H0)
     sta(k)=[];
     dep(k)=[];
else
     sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and selected a starting point that is %4.2f fee
     sprintf('-!! - This may be reasonable for some cases. However the user may want to consider:\n')
     sprintf('-!!-
                                  1) Selecting a starting point that is at or below \$4.2f feet elevation, or\n^{'}, \n^{'} ztoe)
     sprintf('-!!-
                                  2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
- ! ! -
                    setup is adjusted to 0.45 feet
ans =
                   SWEL is adjusted to 9.26 feet
-!!-
k =
         1
         2
         3
         4
         5
         6
       24
       25
       26
```

27 28 29

```
30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2 new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!-----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Ţρ
    % incident spectral mean wave period
    T0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                % here is the intersection of z2 with profile
          \verb"top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)"
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    end
    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
                          % count it as a berm if slope is flatter than 1:15 (see TAW manual)
       if (s < 1/15)
          sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk) berm_width=berm_width+dsta; % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if dh < 0
              chi=R2;
          else
              chi=2* H0;
          end
          if (dh <= R2 \& dh >= -2*H0)
             rdh=(0.5-0.5*cos(3.14159*dh/chi));
          else
            rdh=1;
          end
          rdh_sum=rdh_sum + rdh * dsta
          Berm_Segs=[Berm_Segs, kk];
          Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
       if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
       end
    end
    sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
    berm_width
    rB=berm_width/Lslope
    if (berm_width > 0)
       rdh_mean=rdh_sum/berm_width
       rdh_mean=1
    end
```

```
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
islope=1/slope;
if (slope < 1/8 | slope > 1)
   sprintf('!!!
                 - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
end
if (Irb*gamma berm < 1.8)
   R2_new=gamma*H0*1.77*Irb
else
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
end
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
   disp ('!
              Berm_width is greater than 1/4 wave length')
   disp ('!
              Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm width >= L0
      R2 new=fore R2
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
   else
      w2=(berm_width-0.25*L0)/(0.75*L0)
      w1 = 1 - w2
      R2_new=w2*fore_R2 + w1*R2_new
   end
end % end berm width check
% convergence criterion
R2del=abs(R2-R2_new)
R2_all(iter)=R2_new;
% get the new top station (for plot purposes)
Z2=R2_new+SWEL
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                             % here is the intersection of z2 with profile
      top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
   end
end
if top_sta==-999
   dy=Z2-dep(end);
```

```
top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
       -----! STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
7.2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
         107.041046462901
Lslope =
         145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
         10.1985265021268
rdh_sum =
          2.90420535902459
Berm Factor Calculation: Iteration 1, Profile Segment: 13
         10.4744445021268
rdh_sum =
          3.68942949541434
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
```

```
gamma_berm =
         0.977861924974634
gamma_perm =
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
         0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.0421356450413
R2del =
          8.62226435495869
Z2 =
         23.2980701471681
top_sta =
          46.9993332993712
ans =
    ----- STARTING ITERATION 2 -----!
Ztoe =
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.0421356450413
Z_{2} =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 2, Profile Segment: 10
         9.64669100212682
rdh_sum =
          1.40666398849417
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 2, Profile Segment: 16
```

```
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
   17
rB =
        0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm =
        0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z2 =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
          23.8523348555397
H0 =
                   7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
         14.5964003534129
         23.8523348555397
top_sta =
          50.8951497883595
Lslope =
         89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
         10.1985265021268
rdh_sum =
          2.90420535902459
Berm Factor Calculation: Iteration 3, Profile Segment: 13
```

```
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
           ----- STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z_{2} =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
Berm Factor Calculation: Iteration 4, Profile Segment: 10
```

```
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!---- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm
         0.963805449235703
slope =
         0.366958857822288
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          23.8092710365979
diary off
                 % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
```

```
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\mbox{\ensuremath{\upsigma}}\xspace transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
\ensuremath{\text{\%}} as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup.
               % significant wave height at toe of structure
% peak period, 1/fma,
H0=7.5548;
Tp=9.9345;
\bar{\text{T0}} = \text{Tp}/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                   8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
           417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                  -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^n','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
7.2 =
                  20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
       top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                       % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
end
toe_sta =
         -62.4868075374234
         -38.3813446313046
top_sta =
```

```
34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
   dy=dep(1)-Ztoe;
   toe_sta=sta(1)-dy/S(1)
end
if top sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe_sta
toe_sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*H0 \,
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(dd<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
   dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
   sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup') sprintf('-!!- setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                        SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!-\ The\ User\ has\ selected\ a\ starting\ point\ that\ is\ \$4.2f\ feet\ above\ the\ elevation\ of\ SWEL-1.5H0\n', dep(1\ sprintf('-!!-\ This\ may\ be\ reasonable\ for\ some\ cases.\ However\ the\ user\ may\ want\ to\ consider:\n')
   sprintf('-!!-
                    1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
   sprintf('-!!-
                    2) Reducing the incident wave height to a depth limited condition.\n')
end
ans =
-!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
            setup is adjusted to 0.45 feet
ans =
-!!-
            SWEL is adjusted to 9.26 feet
k =
     1
     2
     3
     4
     5
     6
     7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!-----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    % incident significant wave height
```

```
% incident spectral peak wave period
Тp
% incident spectral mean wave period
т0
R2=R2_new
Z2=R2+SWEL
% determine slope for this iteration
top_sta=-999;
for kk=1:length(sta)-1
   if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                              % here is the intersection of z2 with profile
      top_sta=interpl(dep(kk:kk+1),sta(kk:kk+1),Z2)
      break;
   end
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
% get the length of the slope (not accounting for berm)
Lslope=top_sta-toe_sta
% loop over profile segments to determine berm factor
% re-calculate influence of depth of berm based on this run-up elevation
% check for berm, berm width, berm height
berm_width=0;
rdh_sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                       % count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta; % tally the width of all berm segments % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh <= R2 \& dh >= -2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
      else
         rdh=1;
      end
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma_rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
```

```
if (slope < 1/8 | slope > 1)
       sprintf('!!! - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
       TAW_VALID=0;
    else
       sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
    end
    if TAW_VALID == 0
       TAW_ALWAYS_VALID=0;
    end
    if (Irb*gamma_berm < 1.8)</pre>
       R2_new=gamma*H0*1.77*Irb
    else
       R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
       disp ('! Berm_width is greater than 1/4 wave length')
       disp ('!
                  Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
       % do the foreshore calculation
       fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
       % get upper slope
       fore_toe_sta=-999;
       fore_toe_dep=-999;
       for kk=length(dep)-1:-1:1
          ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
       else
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
          w2=(berm_width-0.25*L0)/(0.75*L0)
          w1 = 1 - w2
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
ans =
        -----! STARTING ITERATION 1 -----!
1----
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
```

end

```
107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   \frac{-}{17}
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma_berm =
         0.977861924974634
gamma perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
        -----! STARTING ITERATION 2 -----!
Ztoe =
```

```
-2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
Z_{2} =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
         9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    17
rB =
         0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
         0.962293906742863
slope =
         0.378674911258111
Irb =
          2.81454975146854
gamma_berm =
         0.962293906742863
gamma_perm =
gamma_beta =
gamma_rough =
```

```
0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z_{2} =
          23.8523348555397
top_sta =
          50.8951497883595
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z2 =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
         9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
```

```
17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578363587244287
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.549424968147
R2del =
        0.0469753852659309
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
       -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
          10.4744445021268
rdh_sum =
          3.68942949541434
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
```

```
10.7503620021268
rdh sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
          11.2205850021268
rdh_sum =
          13.7806281955883
!---- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                        0.6
gamma =
        0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
7.2 =
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
          23.8092710365979
diary off
diary on
                 % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
% calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
\mathsection This script assumes that the incident wave conditions provided \mathsection as input in the configuration section below are the
% appropriate values located at the end of the foreshore
% or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
\ensuremath{\mathtt{\$}} transformation to the incident wave conditions other than
\$ conversion of the peak wave period to the spectral mean wave \$ as recommended in the references below
% references:
\mbox{\ensuremath{\$}} Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
% third column is 0 for excluded points
```

imgname='logfiles/CM-144-1-runup';

```
SWEL=8.8043; % 100-yr still water level including wave setup.
               % significant wave height at toe of structure
H0=7.5548;
Tp=9.9345i
               % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
\label{lower} $\max = 1.5194; \quad $$ only used in case of berm/shallow foreshore weighted average plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                   8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
           417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed % prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                  -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*(^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta; % used for plotting purposes
dep_org=dep;
% initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
7.2 =
                  20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
    if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
       top_sta=interpl(dep(kk:kk+1),sta(kk:kk+1),Z2)
    if
        ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                       % here is the intersection of Ztoe with profile
       toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
    end
end
toe_sta =
         -62.4868075374234
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe sta==-999
   dy=dep(1)-Ztoe;
   toe\_sta=sta(1)-dy/S(1)
end
if top_sta==-999
   dy=Z2-dep(end);
   top_sta=sta(end)+dy/S(end)
end
% just so the reader can tell the values aren't -999 anymore
top_sta
top_sta =
          34.9443976794092
toe sta
toe_sta =
          -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*HO
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*H0
if Ztoe > dep(1)
   dd=SWEL_fore-dep;
   k=find(\overline{dd}<0,1); % k is index of first land point
   staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
```

```
dsta=staAtSWL-sta(1);
   dsetup=maxSetup-setupAtToe;
   dsetdsta=dsetup/dsta;
   setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta)
   sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup') sprintf('-!!- setup is adjusted to %4.2f feet', setup)
   SWEL=SWEL-setupAtToe+setup;
   sprintf('-!!-
                         SWEL is adjusted to %4.2f feet', SWEL)
   k=find(dep < SWEL-1.5*H0)</pre>
   sta(k)=[];
   dep(k)=[];
else
   sprintf('-!!- The User has selected a starting point that is %4.2f feet above the elevation of SWEL-1.5H0\n',dep(1
   sprintf('-!!- This may be reasonable for some cases. However the user may want to consider: `\n') sprintf('-!!- 1) Selecting a starting point that is at or below %4.2f feet elevation, or `\n', Ztoe)
   sprintf('-!!-
                     2) Reducing the incident wave height to a depth limited condition.\n')
-!!- Location of SWEL-1.5*H0 is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-
            setup is adjusted to 0.45 feet
ans =
-!!-
            SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
                     -----!',iter
    sprintf ('!--
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe sta
    % station of top of slope/extent of 2% run-up
    top sta
    % elevation of top of slope/extent of 2% run-up
    z_2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Тp
    % incident spectral mean wave period
    ΤO
    R2=R2 new
    Z2=R2+SWEL
    \mbox{\ensuremath{\mbox{\$}}} determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
        if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                     % here is the intersection of z2 with profile
           top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
           break;
        end
    end
    if top_sta==-999
        dy=Z2-dep(end);
        top_sta=sta(end)+dy/S(end)
    end
    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta
     % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
```

```
% check for berm, berm width, berm height
berm width=0;
rdh sum=0;
Berm_Segs=[];
Berm_Heights=[];
for kk=1:length(sta)-1
   ddep=dep(kk+1)-dep(kk);
   dsta=sta(kk+1)-sta(kk);
   s=ddep/dsta;
   if (s < 1/15)
                       \mbox{\ensuremath{\$}} count it as a berm if slope is flatter than 1:15 (see TAW manual)
      sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
      berm_width=berm_width+dsta; % tally the width of all berm segments
      % compute the rdh for this segment and weight it by the segment length
      dh=SWEL-(dep(kk)+dep(kk+1))/2
      if dh < 0
          chi=R2;
      else
          chi=2* H0;
      end
      if (dh \le R2 \& dh \ge -2*H0)
         rdh=(0.5-0.5*cos(3.14159*dh/chi));
         rdh=1;
      rdh_sum=rdh_sum + rdh * dsta
      Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
   rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm =0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma_perm
gamma_beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW_VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                   - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
   TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
   TAW_ALWAYS_VALID=0;
if (Irb*gamma_berm < 1.8)
    R2_new=gamma*H0*1.77*Irb</pre>
   R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
              Berm_width is greater than 1/4 wave length')
              Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
   for kk=length(dep)-1:-1:1
```

```
ddep=dep(kk+1)-dep(kk);
          dsta=sta(kk+1)-sta(kk);
          s=ddep/dsta;
          if s < 1/15
             break
          end
          fore_toe_sta=sta(kk);
          fore_toe_dep=dep(kk);
          upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
       end
       fore_Irb=upper_slope/(sqrt(fore_H0/L0));
       fore_gamma=gamma_perm*gamma_beta*gamma_rough;
       if (fore_Irb < 1.8)
          fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
          fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
       end
       if berm_width >= L0
          R2_new=fore_R2
          disp ('berm is wider than one wavelength, use full shallow foreshore solution');
       else
          w2=(berm_width-0.25*L0)/(0.75*L0)
          R2_new=w2*fore_R2 + w1*R2_new
       end
    end % end berm width check
    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2 new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
  if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))</pre>
                                                 % here is the intersection of z2 with profile
          top\_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
         ----- STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z2 =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
          10.1985265021268
```

```
rdh_sum =
         2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
         0.116900842243663
rdh_mean =
         0.810625187975784
gamma_berm =
         0.977861924974634
slope =
         0.268771755517362
Irb =
          1.9976804779061
gamma berm =
         0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
         23.2980701471681
top_sta =
          46.9993332993712
ans =
      ----- STARTING ITERATION 2 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
7.2 =
          23.2980701471681
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
          9.49194100212682
```

```
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
         1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
         9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 13
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
rB =
        0.199108280843155
rdh_mean =
         0.810625187975784
gamma_berm =
        0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
gamma\_rough =
                       0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
7.2 =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
    -----! STARTING ITERATION 3 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
         23.8523348555397
```

```
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.5964003534129
Z_{2} =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
Berm Factor Calculation: Iteration 3, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
         11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
         0.190419663210427
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963939312073811
slope =
         0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
         0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
         0.578363587244287
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
```

```
R2\_new =
          14.549424968147
R2del =
        0.0469753852659309
7.2 =
          23.8053594702738
top_sta =
          50.5649673529656
ans =
       -----! STARTING ITERATION 4 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          50.5649673529656
Z_{2} =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
          14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
Berm Factor Calculation: Iteration 4, Profile Segment: 12
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
         10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
```

```
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma_beta =
gamma_rough =
                        0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
          23.8092710365979
top_sta =
          50.5924611241776
% final 2% runup elevation
Z2=R2_new+SWEL
23.8092710365979
diary off
Z2 =
diary on
                 % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-144-1
\mbox{\ensuremath{\$}} calculation by SJH, Ransom Consulting, Inc. 26-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
% chk nld 20200220
% This script assumes that the incident wave conditions provided
% as input in the configuration section below are the
% appropriate values located at the end of the foreshore
\mbox{\ensuremath{\$}} or toe of the slope on which the run-up is being calculated
% the script does not attempt to apply a depth limit or any other
% transformation to the incident wave conditions other than
% conversion of the peak wave period to the spectral mean wave
% as recommended in the references below
% references:
% Van der Meer, J.W., 2002. Technical Report Wave Run-up and
% Wave Overtopping at Dikes. TAW Technical Advisory Committee on
% Flood Defence, The Netherlands.
% FEMA. 2007, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update
fname='inpfiles/CM-144-1sta_ele_include.csv'; % file with station, elevation, include
                                        % third column is 0 for excluded points
imgname='logfiles/CM-144-1-runup';
SWEL=8.8043; % 100-yr still water level including wave setup. H0=7.5548; % significant wave height at toe of structure
Tp=9.9345;
               % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.96381; % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.068077;
maxSetup=1.5194; % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-144-1'
plotTitle =
Iterative TAW for CM-144-1
% END CONFIG
SWEL=SWEL+setupAtToe
SWEL =
                   8.736223
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  10.255623
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
```

```
417.357062285715
% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL; % depth at breaking
\mbox{\ensuremath{\upsigma}} The toe elevation here is only used to determine the average
\$ structure slope, it is not used to depth limit the wave height. \$ Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0
Ztoe =
                              -2.595977
% read the transect
[sta,dep,inc] = textread(fname,'%n%n%n%*[^\n]','delimiter',',','headerlines',0);
% remove unselected points
k=find(inc==0);
sta(k)=[];
dep(k)=[];
sta_org=sta;
                         % used for plotting purposes
dep org=dep;
  initial guess at maximum run-up elevation to estimate slope
Z2=SWEL+1.5*H0
Z2 =
                              20.068423
% determine station at the max runup and -1.5*H0 (i.e. the toe)
top_sta=-999;
toe_sta=-999;
for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                                                 % here is the intersection of z2 with profile
            top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
       end
             ((Ztoe > dep(kk)) & (Ztoe <= dep(kk+1)))
                                                                                             % here is the intersection of Ztoe with profile
       if
            toe_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Ztoe)
       end
end
toe_sta =
                -62.4868075374234
toe_sta =
                -38.3813446313046
top_sta =
                 34.9443976794092
% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta==-999
     dy=dep(1)-Ztoe;
     toe_sta=sta(1)-dy/S(1)
end
if top_sta==-999
     dy=Z2-dep(end);
     top_sta=sta(end)+dy/S(end)
% just so the reader can tell the values aren't -999 anymore
top sta
top_sta =
                 34.9443976794092
toe sta
toe sta =
                -38.3813446313046
% check for case where the toe of slope is below SWL-1.5*HO
% in this case interpolate setup from the setupAtToe(really setup as first station), and the max setup
% also un-include points seaward of SWL-1.5*HO
if Ztoe > dep(1)
     dd=SWEL_fore-dep;
     k=find(\overline{d}d<0,1); % k is index of first land point
     staAtSWL=interp1(dep(k-1:k),sta(k-1:k),SWEL_fore);
     dsta=staAtSWL-sta(1);
     dsetup=maxSetup-setupAtToe;
     dsetdsta=dsetup/dsta;
     setup=setupAtToe+dsetdsta*(toe_sta-sta(1));
     sprintf('-!!- Location of SWEL-1.5*H0 is %4.1f ft landward of toe of slope',dsta) sprintf('-!!- Setup is interpolated between setup at toe of slope and max setup')
     sprintf('-!!-
                                        setup is adjusted to %4.2f feet', setup)
     SWEL=SWEL-setupAtToe+setup;
     sprintf('-!!-
                                         SWEL is adjusted to %4.2f feet', SWEL)
     k=find(dep < SWEL-1.5*H0)</pre>
     sta(k)=[];
     dep(k)=[];
else
     sprintf('-!!- The User has selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected a starting point that is $4.2f feet above the elevation of SWEL-1.5H0\n', dep(1) and the selected as the s
     sprintf('-!!- This may be reasonable for some cases. However the user may want to consider:\n')
     sprintf('-!!-
                                  1) Selecting a starting point that is at or below %4.2f feet elevation, or\n', Ztoe)
     sprintf('-!!-
                                  2) Reducing the incident wave height to a depth limited condition. \n'
end
 -!!- Location of SWEL-1.5*HO is 84.4 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
-!!-
                    setup is adjusted to 0.45 feet
ans =
```

```
-!!-
           SWEL is adjusted to 9.26 feet
k =
     2
     3
     4
     5
     6
7
    24
    25
    26
    27
    28
    29
    30
    31
    32
% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf ('!-----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline
    toe sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z_2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Тр
    % incident spectral mean wave period
    Т0
    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                 % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end)
    % get the length of the slope (not accounting for berm)
    Lslope=top sta-toe sta
    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
       ddep=dep(kk+1)-dep(kk);
       dsta=sta(kk+1)-sta(kk);
       s=ddep/dsta;
          (s < 1/15) % count it as a berm if slope is flatter than 1:15 (see TAW manual) sprintf ('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
       if (s < 1/15)
          berm_width=berm_width+dsta; % tally the width of all berm segments
          % compute the rdh for this segment and weight it by the segment length
          dh=SWEL-(dep(kk)+dep(kk+1))/2
          if dh < 0
              chi=R2;
          else
              chi=2* H0;
          if (dh \le R2 \& dh \ge -2*H0)
             rdh=(0.5-0.5*cos(3.14159*dh/chi));
          else
             rdh=1;
          end
          rdh_sum=rdh_sum + rdh * dsta
```

```
Berm_Segs=[Berm_Segs, kk];
      Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
   end
   if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
      break
   end
end
sprintf ('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
berm_width
rB=berm_width/Lslope
if (berm_width > 0)
   rdh_mean=rdh_sum/berm_width
else
  rdh_mean=1
end
gamma_berm=1- rB * (1-rdh_mean)
if gamma_berm > 1
   gamma_berm=1
end
if gamma_berm < 0.6
   gamma_berm = 0.6
end
% Iribarren number
slope=(Z2-Ztoe)/(Lslope-berm_width)
Irb=(slope/(sqrt(H0/L0)))
% runup height
gamma_berm
gamma perm
gamma beta
gamma rough
gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough
% check validity
TAW VALID=1;
if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
   sprintf('!!! - - Iribaren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gam
   TAW_VALID=0;
else
   sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_
end
islope=1/slope;
if (slope < 1/8 | slope > 1)
    sprintf('!!! - - slope: 1
                  - slope: 1:3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!n', islope)
  TAW_VALID=0;
else
   sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
end
if TAW_VALID == 0
  TAW_ALWAYS_VALID=0;
if (Irb*gamma_berm < 1.8)
  R2_new=gamma*H0*1.77*Irb
  R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
% check to see if we need to evaluate a shallow foreshore
if berm_width > 0.25 * L0;
              Berm_width is greater than 1/4 wave length')
              Runup will be weighted average with foreshore calculation assuming depth limited wave height on ber
   % do the foreshore calculation
   fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
   % get upper slope
   fore_toe_sta=-999;
   fore_toe_dep=-999;
for kk=length(dep)-1:-1:1
      ddep=dep(kk+1)-dep(kk);
      dsta=sta(kk+1)-sta(kk);
      s=ddep/dsta;
      if s < 1/15
         break
      end
      fore_toe_sta=sta(kk);
      fore_toe_dep=dep(kk);
      upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
   end
   fore_Irb=upper_slope/(sqrt(fore_H0/L0));
   fore_gamma=gamma_perm*gamma_beta*gamma_rough;
   if (fore\_Irb < 1.8)
      fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
   else
      fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
   end
   if berm_width >= L0
      disp ('berm is wider than one wavelength, use full shallow foreshore solution');
      w2=(berm_width-0.25*L0)/(0.75*L0)
      w1 = 1 - w2
      R2_new=w2*fore_R2 + w1*R2_new
   end
```

```
end % end berm width check
    % convergence criterion
   R2del=abs(R2-R2_new)
   R2_all(iter)=R2_new;
    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
       if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))
                                                % here is the intersection of z2 with profile
          top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
          break;
       end
    end
    if top_sta==-999
       dy=Z2-dep(end);
       top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;
end
ans =
        -----: STARTING ITERATION 1 -----!
Ztoe =
                 -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          34.9443976794092
Z2 =
                 20.068423
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
                   22.6644
Z_{2} =
          31.9203345021268
top_sta =
          107.041046462901
Lslope =
          145.422391094205
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 12
dh =
          10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
          11.0262795021268
rdh_sum =
          5.32809529031497
Berm Factor Calculation: Iteration 1, Profile Segment: 16
         11.2205850021268
rdh_sum =
```

```
13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
   17
rB =
        0.116900842243663
rdh_mean =
        0.810625187975784
gamma_berm =
         0.977861924974634
slope =
        0.268771755517362
Irb =
          1.9976804779061
gamma\_berm =
        0.977861924974634
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
          0.58671715498478
ans =
!!! - - Iribaren number: 1.95 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.0421356450413
R2del =
          8.62226435495869
Z2 =
         23.2980701471681
top_sta =
          46.9993332993712
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
          46.9993332993712
7.2 =
          23.2980701471681
H0 =
                   7.5548
Tp =
                    9.9345
T0 =
          9.03136363636364
R2 =
         14.0421356450413
Z2 =
          23.2980701471681
top_sta =
          46.9993332993712
Lslope =
          85.3806779306758
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
          9.49194100212682
rdh_sum =
        0.695983762046982
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 12
         10.1985265021268
rdh_sum =
         2.90420535902459
Berm Factor Calculation: Iteration 2, Profile Segment: 13
         10.4744445021268
rdh_sum =
```

```
3.68942949541434
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 14
         10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 15
dh =
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
        0.199108280843155
rdh_mean =
        0.810625187975784
gamma_berm =
        0.962293906742863
slope =
        0.378674911258111
Irb =
         2.81454975146854
gamma_berm =
        0.962293906742863
gamma_perm =
gamma_beta =
    1
gamma_rough =
                       0.6
gamma =
        0.577376344045718
ans =
!!! - - Iribaren number: 2.71 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
         14.5964003534129
R2del =
        0.554264708371569
Z2 =
         23.8523348555397
top_sta =
         50.8951497883595
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
                -2.595977
toe_sta =
         -38.3813446313046
top_sta =
         50.8951497883595
Z2 =
          23.8523348555397
H0 =
                    7.5548
Tp =
                   9.9345
T0 =
         9.03136363636364
R2 =
         14.5964003534129
Z_{2} =
          23.8523348555397
top_sta =
          50.8951497883595
Lslope =
          89.2764944196642
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
          9.49194100212682
rdh_sum =
        0.695983762046982
Berm Factor Calculation: Iteration 3, Profile Segment: 10
         9.64669100212682
rdh_sum =
```

```
1.40666398849417
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 11
dh =
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 12
dh =
         10.1985265021268
rdh_sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 13
dh =
         10.4744445021268
rdh_sum =
         3.68942949541434
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 14
         10.7503620021268
rdh_sum =
         4.49773093822128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
         11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
         11.2205850021268
rdh_sum =
         13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
   17
rB =
        0.190419663210427
rdh_mean =
        0.810625187975784
gamma_berm =
        0.963939312073811
slope =
        0.365932410915933
Irb =
          2.71983948652912
gamma_berm =
        0.963939312073811
gamma_perm =
gamma_beta =
gamma_rough =
                       0.6
gamma =
        0.578363587244287
ans =
!!! - - Iribaren number: 2.62 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
          14.549424968147
R2del =
       0.0469753852659309
Z2 =
         23.8053594702738
top_sta =
         50.5649673529656
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
                -2.595977
toe_sta =
        -38.3813446313046
top_sta =
         50.5649673529656
Z2 =
          23.8053594702738
H0 =
                    7.5548
Tp =
                    9.9345
T0 =
         9.03136363636364
R2 =
```

```
14.549424968147
Z2 =
          23.8053594702738
top_sta =
          50.5649673529656
Lslope =
          88.9463119842703
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
          9.49194100212682
rdh_sum =
         0.695983762046982
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
          9.64669100212682
rdh_sum =
          1.40666398849417
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 11
          9.92260850212682
rdh_sum =
          2.14299703977601
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 12
          10.1985265021268
rdh sum =
          2.90420535902459
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 13
dh =
          10.4744445021268
rdh_sum =
          3.68942949541434
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 14
dh =
          10.7503620021268
rdh_sum =
          4.49773093822128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
          11.0262795021268
rdh_sum =
          5.32809529031497
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
          11.2205850021268
rdh_sum =
          13.7806281955883
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
   17
rB =
         0.191126530383928
rdh_mean =
         0.810625187975784
gamma_berm =
         0.963805449235703
slope =
         0.366958857822288
Irb =
          2.72746868455436
gamma_berm =
         0.963805449235703
gamma_perm =
gamma beta =
gamma_rough =
                       0.6
gamma =
         0.578283269541422
ans =
!!! - - Iribaren number: 2.63 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
!!! - - slope: 1:2.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2\_new =
           14.553336534471
R2del =
       0.00391156632409739
          23.8092710365979
top_sta =
```

50.5924611241776 % final 2% runup elevation Z2=R2_new+SWEL Z2 =

23.8092710365979 diary off -1.000000e+00 -1.000000e+00