```
diary on         % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-145
% calculation by SJH, Ransom Consulting, Inc. 20-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-145sta_ele_include.csv';   % file with station, elevation, include
                                      % third colunm is 0 for excluded points
imgname='logfiles/CM-145-runup';
SWEL=8.8099;  % 100-yr still water level including wave setup.
H0=8.5251;    % significant wave height at toe of structure
Tp=11.4911;    % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.95254;   % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=-0.03793;
maxSetup=1.1002;   % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-145'

plotTitle =

Iterative TAW for CM-145



% END CONFIG
%------------------------------

SWEL=SWEL+setupAtToe

SWEL =

                   8.77197

SWEL_fore=SWEL+maxSetup

SWEL_fore =

                   9.87217



% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2

L0 =

          558.391690298303


% 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 =

                  -4.01568


% 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 =

                  21.55962


% 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
    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 =

         -23.9617354939885


top_sta =

          68.6101870716799

% 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 =

          68.6101870716799

toe_sta

toe_sta =

         -23.9617354939885




% 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*H0 is 65.1 ft landward of toe of slope


ans =

-!!- Setup is interpolated between setup at toe of slope and max setup


ans =

-!!-       setup is adjusted to 0.14 feet


ans =

-!!-       SWEL is adjusted to 8.95 feet


k =

     1
     2
     3
     4
     5
     6
     7
     8
     9
    10
    11



% 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
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % 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:%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)
          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 =
                  -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          68.6101870716799
Z2 =
                  21.55962
H0 =
                    8.5251
Tp =
                   11.4911
T0 =
          10.4464545454545
R2 =
                   25.5753
Z2 =
          34.5228664642314
top_sta =
          126.983337402331
Lslope =
           150.94507289632
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
         0.803005262087444
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 7
dh =
          12.0481914642314
```

```
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.19647261320465
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.64774225273241
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.10117009312888
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
           3.5574177460719
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    10
rB =
        0.0662492641072739
rdh_mean =
           0.35574177460719
gamma_berm =
          0.957318366672668
slope =
          0.273429540120077
Irb =
           2.21291720002817
gamma_berm =
          0.957318366672668
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
          0.765854693338135
ans =
!!! - - Iribaren number:   2.12 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 =
           21.052284975238
R2del =
          4.52301502476195
Z2 =
          29.9998514394695
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                   -4.01568
toe_sta =
         -23.9617354939885
```

```
top_sta =
          97.8120054141856
Z2 =
          29.9998514394695
H0 =
                    8.5251
Tp =
                   11.4911
T0 =
          10.4464545454545
R2 =
           21.052284975238
Z2 =
          29.9998514394695
top_sta =
          97.8120054141856
Lslope =
          121.773740908174
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
         0.803005262087444
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.35348948813796
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.96206378207293
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.57320758355696
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
          4.18770237606831
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    10
rB =
        0.0821195105399669
rdh_mean =
          0.418770237606831
gamma_berm =
          0.952269696401012
slope =
          0.304324890292563
```

```
Irb =
          2.46295913685608
gamma_berm =
         0.952269696401012
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
         0.761815757120809
ans =
!!! - - Iribaren number:   2.35 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 =
          21.3053260939424
R2del =
         0.253041118704378
Z2 =
          30.2528925581738
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                  -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          99.4440023100539
Z2 =
          30.2528925581738
H0 =
                    8.5251
Tp =
                   11.4911
T0 =
          10.4464545454545
R2 =
          21.3053260939424
Z2 =
          30.2528925581738
top_sta =
          99.4440023100539
Lslope =
          123.405737804042
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
         0.803005262087444
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.34310470848153
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 87
```

```
dh =
        -11.9929835357686
rdh_sum =
         2.94128088302934
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 88
dh =
        -12.0282835357686
rdh_sum =
         3.54200764410173
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 89
dh =
        -12.0743835357686
rdh_sum =
         4.14606122127127
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    10
rB =
       0.0810335092836537
rdh_mean =
        0.414606122127127
gamma_berm =
        0.952563479762795
slope =
        0.302176708354807
Irb =
         2.44557349243462
gamma_berm =
        0.952563479762795
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                      0.8
gamma =
        0.762050783810236
ans =
!!! - - Iribaren number:   2.33 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 =
         21.2883980394838
R2del =
        0.016928054458667
Z2 =
         30.2359645037152
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                  -4.01568
toe_sta =
        -23.9617354939885
top_sta =
         99.3348242742031
Z2 =
        30.2359645037152
H0 =
                   8.5251
Tp =
                  11.4911
T0 =
        10.4464545454545
R2 =
        21.2883980394838
Z2 =
         30.2359645037152
top_sta =
         99.3348242742031
Lslope =
        123.296559768192
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 6
dh =
         12.0584414642314
rdh_sum =
        0.803005262087444
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 7
dh =
         12.0481914642314
rdh_sum =
         1.60525882777874
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 42
dh =
         2.13091646423142
```

```
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.34379311999204
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.94265861905729
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.54407600068065
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
          4.14882185617557
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    10
rB =
        0.0811052637543244
rdh_mean =
          0.414882185617557
gamma_berm =
          0.952543865337158
slope =
          0.302318486755424
Irb =
           2.44672093195846
gamma_berm =
          0.952543865337158
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
          0.762035092269727
ans =
!!! - - Iribaren number:   2.33 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 =
          21.2895184139499
R2del =
       0.00112037446614011
Z2 =
          30.2370848781813
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          30.2370848781813
diary off
-1.000000e+00
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-145
% 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-145sta_ele_include.csv';   % file with station, elevation, include
                                    % third colunm is 0 for excluded points
imgname='logfiles/CM-145-runup';
SWEL=8.8099;  % 100-yr still water level including wave setup.
H0=8.5251;    % significant wave height at toe of structure
Tp=11.4911;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.95254;   % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.03793;
maxSetup=1.1002;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-145'
plotTitle =
Iterative TAW for CM-145
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                  8.77197
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  9.87217
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          558.391690298303
% 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 =
                 -4.01568
% 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 =
                 21.55962
% 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
    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 =
         -23.9617354939885
```

```
top_sta =
         68.6101870716799
% 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 =
         68.6101870716799
toe_sta
toe_sta =
        -23.9617354939885
% 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*H0 is 65.1 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.14 feet
ans =
-!!-       SWEL is adjusted to 8.95 feet
k =
     1
     2
     3
     4
     5
     6
     7
     8
     9
    10
    11
% 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
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % 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:%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)
         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 =
                -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          68.6101870716799
Z2 =
                 21.55962
H0 =
                   8.5251
Tp =
                  11.4911
T0 =
          10.4464545454545
R2 =
                  25.5753
Z2 =
          34.5228664642314
top_sta =
          126.983337402331
Lslope =
           150.94507289632
ans =
```

```
Berm Factor Calculation: Iteration 1, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
         0.803005262087444
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.19647261320465
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.64774225273241
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.10117009312888
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
           3.5574177460719
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    10
rB =
        0.0662492641072739
rdh_mean =
           0.35574177460719
gamma_berm =
          0.957318366672668
slope =
          0.273429540120077
Irb =
           2.21291720002817
gamma_berm =
          0.957318366672668
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
          0.765854693338135
ans =
!!! - - Iribaren number:   2.12 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 =
           21.052284975238
R2del =
```

```
          4.52301502476195
Z2 =
          29.9998514394695
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                  -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          97.8120054141856
Z2 =
          29.9998514394695
H0 =
                    8.5251
Tp =
                   11.4911
T0 =
          10.4464545454545
R2 =
           21.052284975238
Z2 =
          29.9998514394695
top_sta =
          97.8120054141856
Lslope =
          121.773740908174
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
         0.803005262087444
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.35348948813796
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.96206378207293
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.57320758355696
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
          4.18770237606831
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
```

```
    10
rB =
        0.0821195105399669
rdh_mean =
        0.418770237606831
gamma_berm =
        0.952269696401012
slope =
        0.304324890292563
Irb =
         2.46295913685608
gamma_berm =
        0.952269696401012
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
        0.761815757120809
ans =
!!! - - Iribaren number:   2.35 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 =
         21.3053260939424
R2del =
        0.253041118704378
Z2 =
         30.2528925581738
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                  -4.01568
toe_sta =
         -23.9617354939885
top_sta =
         99.4440023100539
Z2 =
         30.2528925581738
H0 =
                   8.5251
Tp =
                  11.4911
T0 =
        10.4464545454545
R2 =
        21.3053260939424
Z2 =
        30.2528925581738
top_sta =
        99.4440023100539
Lslope =
        123.405737804042
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 6
dh =
        12.0584414642314
rdh_sum =
        0.803005262087444
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 7
dh =
        12.0481914642314
rdh_sum =
        1.60525882777874
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 42
dh =
        2.13091646423142
rdh_sum =
        1.64330635863373
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 43
dh =
        2.07781646423143
rdh_sum =
        1.67950425045875
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 44
dh =
        2.02601646423143
rdh_sum =
        1.71394056532371
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 45
dh =
        1.97551646423143
rdh_sum =
```

```
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.34310470848153
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.94128088302934
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.54200764410173
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
          4.14606122127127
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    10
rB =
        0.0810335092836537
rdh_mean =
          0.414606122127127
gamma_berm =
          0.952563479762795
slope =
          0.302176708354807
Irb =
          2.44557349243462
gamma_berm =
          0.952563479762795
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
          0.762050783810236
ans =
!!! - - Iribaren number:   2.33 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 =
          21.2883980394838
R2del =
          0.016928054458667
Z2 =
          30.2359645037152
ans =
!----------------- STARTING ITERATION 4 -----------------!
Ztoe =
                    -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          99.3348242742031
Z2 =
          30.2359645037152
H0 =
                     8.5251
Tp =
                    11.4911
T0 =
          10.4464545454545
R2 =
          21.2883980394838
Z2 =
          30.2359645037152
top_sta =
          99.3348242742031
Lslope =
          123.296559768192
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
          0.803005262087444
ans =
```

```
Berm Factor Calculation: Iteration 4, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.34379311999204
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.94265861905729
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.54407600068065
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
          4.14882185617557
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
    10
rB =
       0.0811052637543244
rdh_mean =
          0.414882185617557
gamma_berm =
          0.952543865337158
slope =
          0.302318486755424
Irb =
           2.44672093195846
gamma_berm =
          0.952543865337158
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
          0.762035092269727
ans =
!!! - - Iribaren number:   2.33 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 =
          21.2895184139499
R2del =
       0.00112037446614011
Z2 =
          30.2370848781813
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
```

```
          30.2370848781813
diary off
diary on         % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-145
% 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-145sta_ele_include.csv';   % file with station, elevation, include
                                    % third colunm is 0 for excluded points
imgname='logfiles/CM-145-runup';
SWEL=8.8099;  % 100-yr still water level including wave setup.
H0=8.5251;    % significant wave height at toe of structure
Tp=11.4911;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=0.95254;   % this may get changed automatically below
gamma_rough=0.6;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.03793;
maxSetup=1.1002;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-145'
plotTitle =
Iterative TAW for CM-145
% END CONFIG
%------------------------------
SWEL=SWEL+setupAtToe
SWEL =
                  8.77197
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                  9.87217
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          558.391690298303
% 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 =
                 -4.01568
% 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 =
                 21.55962
% 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
    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 =
        -23.9617354939885
top_sta =
         68.6101870716799
% 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 =
         68.6101870716799
toe_sta
toe_sta =
        -23.9617354939885
% 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*H0 is 65.1 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-       setup is adjusted to 0.14 feet
ans =
-!!-       SWEL is adjusted to 8.95 feet
k =
     1
     2
     3
     4
     5
     6
     7
     8
     9
    10
    11
% 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
```

```
top_sta
% elevation of top of slope/extent of 2% run-up
Z2
% incident significant wave height
H0
% incident spectral peak wave period
Tp
% 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:%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)
          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 =
                  -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          68.6101870716799
Z2 =
                  21.55962
H0 =
                    8.5251
Tp =
                   11.4911
T0 =
          10.4464545454545
R2 =
```

```
                  25.5753
Z2 =
          34.5228664642314
top_sta =
          126.983337402331
Lslope =
           150.94507289632
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
         0.803005262087444
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.19647261320465
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          2.64774225273241
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          3.10117009312888
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
           3.5574177460719
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
    10
rB =
        0.0662492641072739
rdh_mean =
          0.35574177460719
gamma_berm =
          0.957318366672668
slope =
          0.273429540120077
Irb =
          2.21291720002817
gamma_berm =
          0.957318366672668
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.6
gamma =
```

```
         0.574391020003601
ans =
!!! - - Iribaren number:   2.12 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 =
          15.7892137314285
R2del =
          9.78608626857146
Z2 =
            24.73678019566
top_sta =
          74.8059253070242
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                 -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          74.8059253070242
Z2 =
            24.73678019566
H0 =
                    8.5251
Tp =
                   11.4911
T0 =
          10.4464545454545
R2 =
          15.7892137314285
Z2 =
            24.73678019566
top_sta =
          74.8059253070242
Lslope =
          98.7676608010127
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
         0.803005262087444
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.60904400286677
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 87
dh =
          -11.9929835357686
rdh_sum =
          3.47306290659196
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
```

```
          4.33948030228988
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
           5.2090027706825
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
    10
rB =
          0.101247715283518
rdh_mean =
           0.52090027706825
gamma_berm =
          0.951492247660194
slope =
          0.323906926646556
Irb =
           2.62144027623954
gamma_berm =
          0.951492247660194
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.570895348596116
ans =
!!! - - Iribaren number:   2.49 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.1 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          16.1182746564473
R2del =
          0.329060925018737
Z2 =
          25.0658411206787
top_sta =
          75.3190007338874
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                   -4.01568
toe_sta =
         -23.9617354939885
top_sta =
          75.3190007338874
Z2 =
          25.0658411206787
H0 =
                     8.5251
Tp =
                    11.4911
T0 =
          10.4464545454545
R2 =
          16.1182746564473
Z2 =
          25.0658411206787
top_sta =
          75.3190007338874
Lslope =
          99.2807362278759
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 6
dh =
          12.0584414642314
rdh_sum =
          0.803005262087444
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 7
dh =
          12.0481914642314
rdh_sum =
          1.60525882777874
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 42
dh =
          2.13091646423142
rdh_sum =
          1.64330635863373
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 43
dh =
          2.07781646423143
rdh_sum =
```

```
          1.67950425045875
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 44
dh =
          2.02601646423143
rdh_sum =
          1.71394056532371
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 45
dh =
          1.97551646423143
rdh_sum =
          1.74670033892783
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 86
dh =
         -11.9684835357686
rdh_sum =
          2.59187210790687
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 87
dh =
         -11.9929835357686
rdh_sum =
          3.43876734155537
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 88
dh =
         -12.0282835357686
rdh_sum =
          4.28813185182255
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 89
dh =
         -12.0743835357686
rdh_sum =
          5.14069619158641
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
    10
rB =
          0.100724474655862
rdh_mean =
          0.514069619158641
gamma_berm =
          0.951054917670431
slope =
          0.325731197449497
Irb =
          2.63620444632726
gamma_berm =
          0.951054917670431
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.6
gamma =
          0.570632950602259
ans =
!!! - - Iribaren number:   2.51 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.1 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          16.1243470873076
R2del =
        0.0060724308603497
Z2 =
           25.071913551539
top_sta =
          75.3284689351197
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
           25.071913551539
diary off
-1.000000e+00
```