```
diary on         % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-134
% 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-134sta_ele_include.csv';   % file with station, elevation, include
                                      % third colunm is 0 for excluded points
imgname='logfiles/CM-134-runup';
SWEL=8.9062;  % 100-yr still water level including wave setup.
H0=3.4461;    % significant wave height at toe of structure
Tp=4.9744;    % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.96945;   % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=-0.028737;
maxSetup=0.28085;   % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-134'

plotTitle =

Iterative TAW for CM-134



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

SWEL=SWEL+setupAtToe

SWEL =

                  8.877463

SWEL_fore=SWEL+maxSetup

SWEL_fore =

                  9.158313



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

L0 =

           104.63985953151


% 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 =

                  3.708313


% 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 =

                 14.046613


% 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 =

          42.0902813852814


top_sta =

          74.9508498793839

% 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 =

          74.9508498793839

toe_sta

toe_sta =

          42.0902813852814




% 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 44.1 ft landward of toe of slope


ans =

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


ans =

-!!-       setup is adjusted to 0.11 feet


ans =

-!!-       SWEL is adjusted to 9.02 feet


k =

     1
     2
     3
     4
     5
     6
     7
     8
     9
    10
    11
    12
    13
    14
    15
    16
    17
    18
    19
    20
    21
    22



% 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 =
                3.708313
toe_sta =
          42.0902813852814
top_sta =
          74.9508498793839
Z2 =
               14.046613
H0 =
                  3.4461
Tp =
                  4.9744
T0 =
          4.52218181818182
R2 =
                 10.3383
Z2 =
          19.3569002507025
top_sta =
          84.4259802339595
Lslope =
          42.3356988486781
```

```
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 5
dh =
          4.43212525070251
rdh_sum =
         0.717233715067087
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 6
dh =
          4.37357525070251
rdh_sum =
          1.42237265434004
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 7
dh =
          4.31772525070251
rdh_sum =
          2.11583828478497
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 8
dh =
          4.26457525070251
rdh_sum =
          2.79807839453589
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
     4
rB =
         0.094482909430581
rdh_mean =
         0.699519598633972
gamma_berm =
         0.971609737452069
slope =
         0.408198825655219
Irb =
          2.24934663306111
gamma_berm =
         0.971609737452069
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
         0.777287789961655
ans =
!!! - - Iribaren number:   2.19 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.4 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          8.66042876527054
R2del =
          1.67787123472946
Z2 =
          17.6790290159731
top_sta =
           81.554597443267
ans =
!----------------- STARTING ITERATION 2 -----------------!
Ztoe =
                  3.708313
toe_sta =
          42.0902813852814
top_sta =
           81.554597443267
Z2 =
          17.6790290159731
H0 =
                    3.4461
Tp =
                    4.9744
T0 =
          4.52218181818182
R2 =
          8.66042876527054
Z2 =
          17.6790290159731
top_sta =
           81.554597443267
Lslope =
          39.4643160579856
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 5
dh =
          4.43212525070251
rdh_sum =
         0.717233715067087
```

```
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 6
dh =
          4.37357525070251
rdh_sum =
          1.42237265434004
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 7
dh =
          4.31772525070251
rdh_sum =
          2.11583828478497
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 8
dh =
          4.26457525070251
rdh_sum =
          2.79807839453589
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
     4
rB =
         0.101357388130653
rdh_mean =
         0.699519598633972
gamma_berm =
         0.969544091333089
slope =
         0.393937274671542
Irb =
          2.17075950916169
gamma_berm =
         0.969544091333089
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
         0.775635273066471
ans =
!!! - - Iribaren number:   2.10 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          8.59085924716618
R2del =
        0.0695695181043661
Z2 =
          17.6094594978687
top_sta =
          81.4355429072793
ans =
!----------------- STARTING ITERATION 3 -----------------!
Ztoe =
                  3.708313
toe_sta =
          42.0902813852814
top_sta =
          81.4355429072793
Z2 =
          17.6094594978687
H0 =
                    3.4461
Tp =
                    4.9744
T0 =
          4.52218181818182
R2 =
          8.59085924716618
Z2 =
          17.6094594978687
top_sta =
          81.4355429072793
Lslope =
           39.345261521998
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 5
dh =
          4.43212525070251
rdh_sum =
         0.717233715067087
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 6
dh =
          4.37357525070251
rdh_sum =
          1.42237265434004
```

```
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 7
dh =
          4.31772525070251
rdh_sum =
          2.11583828478497
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 8
dh =
          4.26457525070251
rdh_sum =
          2.79807839453589
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
     4
rB =
          0.101664084702134
rdh_mean =
          0.699519598633972
gamma_berm =
          0.969451935024193
slope =
          0.393295901608112
Irb =
          2.16722527473942
gamma_berm =
          0.969451935024193
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                       0.8
gamma =
          0.775561548019355
ans =
!!! - - Iribaren number:   2.10 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          8.58767706873285
R2del =
       0.00318217843332214
Z2 =
          17.6062773194354
top_sta =
          81.4300972352791
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          17.6062773194354
diary off
-1.000000e+00
-1.000000e+00
```