```
diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-150-2
% 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-150-2sta_ele_include.csv';   % file with station, elevation, include
                                   % third colunm is 0 for excluded points
imgname='logfiles/CM-150-2-runup';
SWEL=8.9231;  % 100-yr still water level including wave setup.
H0=3.1328;    % significant wave height at toe of structure
Tp=8.6753;    % 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=-0.025892;
maxSetup=0.27652;   % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-150-2'

plotTitle =

Iterative TAW for CM-150-2


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

```
SWEL=SWEL+setupAtToe

SWEL =

             8.897208

SWEL_fore=SWEL+maxSetup

SWEL_fore =

             9.173728



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

L0 =

       318.261967049778


% 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
```

```matlab
% 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 =

                4.198008


% 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 =

                13.596408


% 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 =

        10.8823897620474


top_sta =

        27.3012074058466

% 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 =

        27.3012074058466

toe_sta

toe_sta =

        10.8823897620474



% 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 11.5 ft landward of toe of slope


ans =

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


ans =

-!!-       setup is adjusted to 0.08 feet


ans =

-!!-       SWEL is adjusted to 9.00 feet


k =

     1
     2
     3
     4
     5



% 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 =
                4.198008
toe_sta =
        10.8823897620474
top_sta =
        27.3012074058466
Z2 =
                13.596408
H0 =
                3.1328
Tp =
                8.6753
T0 =
        7.88663636363636
R2 =
                9.3984
Z2 =
        18.3976160809072
top_sta =
        38.3693497888371
Lslope =
        27.4869600267897
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
     0
rB =
     0
rdh_mean =
     1
gamma_berm =
     1
slope =
        0.51659434902266
Irb =
        5.20685739140577
gamma_berm =
```

```
        1
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
     1
ans =
!!! - - Iribaren number:   5.21 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:1.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
        11.2743700388112
R2del =
        1.87597003881122
Z2 =
        20.2735861197185
top_sta =
        48.6203040653157
ans =
!---------------- STARTING ITERATION 2 -----------------!
Ztoe =
                4.198008
toe_sta =
        10.8823897620474
top_sta =
        48.6203040653157
Z2 =
        20.2735861197185
H0 =
                  3.1328
Tp =
                  8.6753
T0 =
        7.88663636363636
R2 =
        11.2743700388112
Z2 =
        20.2735861197185
top_sta =
        48.6203040653157
Lslope =
        37.7379143032683
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
     0
rB =
     0
rdh_mean =
     1
gamma_berm =
     1
slope =
        0.425979506724521
Irb =
        4.29353238059373
gamma_berm =
     1
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
     1
ans =
!!! - - Iribaren number:   4.29 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
        11.0519875687306
R2del =
        0.222382470080627
Z2 =
        20.0512036496378
top_sta =
        47.5356511835164
ans =
!---------------- STARTING ITERATION 3 -----------------!
Ztoe =
                4.198008
toe_sta =
        10.8823897620474
top_sta =
        47.5356511835164
Z2 =
```

```
                  20.0512036496378
H0 =
                           3.1328
Tp =
                           8.6753
T0 =
          7.88663636363636
R2 =
          11.0519875687306
Z2 =
          20.0512036496378
top_sta =
          47.5356511835164
Lslope =
          36.6532614214691
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
     0
rB =
     0
rdh_mean =
     1
gamma_berm =
     1
slope =
          0.432518008898168
Irb =
          4.35943524765652
gamma_berm =
     1
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
     1
gamma =
     1
ans =
!!! - - Iribaren number:   4.36 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          11.0703419642589
R2del =
        0.0183543955283003
Z2 =
          20.0695580451661
top_sta =
          47.6294300284393
ans =
!---------------- STARTING ITERATION 4 -----------------!
Ztoe =
                           4.198008
toe_sta =
          10.8823897620474
top_sta =
          47.6294300284393
Z2 =
          20.0695580451661
H0 =
                           3.1328
Tp =
                           8.6753
T0 =
          7.88663636363636
R2 =
          11.0703419642589
Z2 =
          20.0695580451661
top_sta =
          47.6294300284393
Lslope =
          36.7470402663919
ans =
!------- End Berm Factor Calculation, Iter: 4 ---------!
berm_width =
     0
rB =
     0
rdh_mean =
     1
gamma_berm =
     1
slope =
          0.431913697813697
Irb =
          4.35334427574784
gamma_berm =
```

```
       1
gamma_perm =
       1
gamma_beta =
       1
gamma_rough =
       1
gamma =
       1
ans =
!!! - - Iribaren number:   4.35 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          11.0686630856592
R2del =
       0.00167887859964999
Z2 =
          20.0678791665665
top_sta =
          47.6208520670677
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
          20.0678791665665
diary off
-1.000000e+00
diary on          % begin recording
% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-150-2
% calculation by SJH, Ransom Consulting, Inc. 03-Mar-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-150-2sta_ele_include.csv';   % file with station, elevation, include
                                    % third colunm is 0 for excluded points
imgname='logfiles/CM-150-2-runup';
SWEL=8.9231;  % 100-yr still water level including wave setup.
H0=3.1328;    % significant wave height at toe of structure
Tp=8.6753;    % peak period, 1/fma,
T0=Tp/1.1;
gamma_berm=1;   % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;
setupAtToe=-0.025892;
maxSetup=0.27652;   % only used in case of berm/shallow foreshore weighted average
plotTitle='Iterative TAW for CM-150-2'
plotTitle =
Iterative TAW for CM-150-2
% END CONFIG
%-----------------------------
SWEL=SWEL+setupAtToe
SWEL =
                 8.897208
SWEL_fore=SWEL+maxSetup
SWEL_fore =
                 9.173728
% FIND WAVELENGTH USING DEEPWATER DISPERSION RELATION
% using English units
L0=32.15/(2*pi)*T0^2
L0 =
          318.261967049778
% 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 =
                  4.198008
% 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 =
                  13.596408
% 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 =
         10.8823897620474
top_sta =
         27.3012074058466
% 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 =
         27.3012074058466
toe_sta
toe_sta =
         10.8823897620474
% 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 11.5 ft landward of toe of slope
ans =
-!!- Setup is interpolated between setup at toe of slope and max setup
ans =
-!!-        setup is adjusted to 0.08 feet
ans =
-!!-        SWEL is adjusted to 9.00 feet
k =
     1
     2
     3
     4
```

```matlab
% 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 =
                   4.198008
toe_sta =
          10.8823897620474
top_sta =
          27.3012074058466
Z2 =
                  13.596408
H0 =
                     3.1328
Tp =
                     8.6753
T0 =
          7.88663636363636
R2 =
                     9.3984
Z2 =
          18.3976160809072
top_sta =
          38.3693497888371
Lslope =
          27.4869600267897
ans =
!------- End Berm Factor Calculation, Iter: 1 ---------!
berm_width =
     0
rB =
     0
rdh_mean =
     1
gamma_berm =
     1
slope =
         0.516594343902266
Irb =
          5.20685739140577
gamma_berm =
     1
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                        0.8
gamma =
                        0.8
ans =
!!! - - Iribaren number:   5.21 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:1.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
          9.01949603104898
R2del =
         0.378903968951022
Z2 =
          18.0187121119562
top_sta =
          36.2578483449499
ans =
!---------------- STARTING ITERATION 2 ----------------!
Ztoe =
                   4.198008
toe_sta =
          10.8823897620474
top_sta =
          36.2578483449499
Z2 =
          18.0187121119562
H0 =
                     3.1328
Tp =
                     8.6753
T0 =
          7.88663636363636
R2 =
          9.01949603104898
Z2 =
          18.0187121119562
top_sta =
          36.2578483449499
Lslope =
          25.3754585829025
ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!
berm_width =
     0
```

```
rB =
     0
rdh_mean =
     1
gamma_berm =
     1
slope =
        0.544648447112927
Irb =
        5.48962029112757
gamma_berm =
     1
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                    0.8
gamma =
                    0.8
ans =
!!! - - Iribaren number:   5.49 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:1.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
        9.06535334638421
R2del =
        0.045857315335228
Z2 =
        18.0645694272914
top_sta =
        36.5133963080544
ans =
!---------------- STARTING ITERATION 3 -----------------!
Ztoe =
                4.198008
toe_sta =
        10.8823897620474
top_sta =
        36.5133963080544
Z2 =
        18.0645694272914
H0 =
                3.1328
Tp =
                8.6753
T0 =
        7.88663636363636
R2 =
        9.06535334638421
Z2 =
        18.0645694272914
top_sta =
        36.5133963080544
Lslope =
        25.6310065460071
ans =
!------- End Berm Factor Calculation, Iter: 3 ---------!
berm_width =
     0
rB =
     0
rdh_mean =
     1
gamma_berm =
     1
slope =
        0.541007291399239
Irb =
        5.45292035671122
gamma_berm =
     1
gamma_perm =
     1
gamma_beta =
     1
gamma_rough =
                    0.8
gamma =
                    0.8
ans =
!!! - - Iribaren number:   5.45 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:1.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
        9.05960359950507
R2del =
        0.0057497468791361
Z2 =
        18.0588196804123
```

```
top_sta =
           36.4813548313001
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
           18.0588196804123
diary off
-1.000000e+00
```