```
diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: YK-14
% calculation by SJH, Ransom Consulting, Inc. 06-Feb-2020
% 100-year wave runup using TAW methodology
% including berm and weighted average with foreshore if necessary
%
% chk nld 20181015
%
% 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/YK-14sta_ele_include.csv';   % file with station, elevation, include
                                    % third colunm is 0 for excluded points
imgname='logfiles/YK-14-runup';
SWEL=9.19;  % 100-yr still water level including wave setup.
H0=4.9688;    % significant wave height at toe of structure
Tp=13.8709;    % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.94964;   % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=0.5381;
maxSetup=1.1359;   % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for YK-14'

plotTitle =

Iterative TAW for YK-14



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

SWEL=SWEL+setupAtToe

SWEL =

                9.7281

SWEL_fore=SWEL+maxSetup

SWEL_fore =

                10.864



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

L0 =

        813.626378047832


% Find Hb (Munk, 1949)
%Hb=H0/(3.3*(H0/L0)^(1/3))
%Db=-Hb/.78+SWEL;  % depth at breaking

% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height
% to make it consitent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0

Ztoe =
```

```
                        2.2749


% 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 =

                    17.1813


% 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
% 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

toe_sta =

          148.690355329948

if top_sta==-999
    dy=Z2-dep(end);
    top_sta=sta(end)+dy/S(end)
end

top_sta =

          173.496221662469


% just so the reader can tell the values aren't -999 anymore
top_sta

top_sta =

          173.496221662469

toe_sta

toe_sta =

          148.690355329948



% 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',de
    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 =

-!!- The User has selected a starting point that is 1.22 feet above the elevation of SWEL-1.5H0


ans =

-!!- This may be reasonable for some cases.  However the user may want to consider:


ans =

-!!-   1) Selecting a starting point that is at or below 2.27 feet elevation, or


ans =

-!!-   2) Reducing the incident wave height to a depth limited condition.




% now iterate converge on a runup elevation
tol=0.001;  % 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*
    TAW_VALID=0;
else
    sprintf('!!! - - Iribaren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gam
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', islop
    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
    % do the foreshore calculation
    fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
    % get upper slope
    fore_toe_sta=-999;
    fore_toe_dep=-999;
    for kk=length(dep)-1:-1:1
        ddep=dep(kk+1)-dep(kk);
        dsta=sta(kk+1)-sta(kk);
        s=ddep/dsta;
        if s < 1/15
            break
        end
        fore_toe_sta=sta(kk);
        fore_toe_dep=dep(kk);
        upper_slope=(Z2-fore_toe_dep)/(top_sta-fore_toe_sta)
    end
    fore_Irb=upper_slope/(sqrt(fore_H0/L0));
    fore_gamma=gamma_perm*gamma_beta*gamma_rough;
    if (fore_Irb < 1.8)
        fore_R2=fore_gamma*fore_H0*1.77*fore_Irb;
    else
        fore_R2=fore_gamma*fore_H0*(4.3-(1.6/sqrt(fore_Irb)));
    end
    if berm_width >= L0
        R2_new=fore_R2
        disp ('berm is wider than one wavelength, use full shallow foreshore solution');
    else
        w2=(berm_width-0.25*L0)/(0.75*L0)
        w1=1-w2
```

```
            R2_new=w2*fore_R2 + w1*R2_new
        end
    end % end berm width check

    % convergence criterion
    R2del=abs(R2-R2_new)
    R2_all(iter)=R2_new;

    % get the new top station (for plot purposes)
    Z2=R2_new+SWEL
    top_sta=-999;
    for kk=1:length(sta)-1
        if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1)))    % here is the intersection of z2 with profile
            top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
            break;
        end
    end
    if top_sta==-999
        dy=Z2-dep(end);
        top_sta=sta(end)+dy/S(end);
    end
    topStaAll(iter)=top_sta;

end

ans =

!---------------- STARTING ITERATION 1 ----------------!


Ztoe =

                  2.2749


toe_sta =

       148.690355329948


top_sta =

       173.496221662469


Z2 =

                 17.1813


H0 =

                  4.9688


Tp =

                 13.8709


T0 =

       12.6099090909091


R2 =

                 14.9064


Z2 =

                 24.6345


top_sta =

        236.07556675063


Lslope =

       87.3852114206816


ans =

Berm Factor Calculation: Iteration 1, Profile Segment: 1


dh =

                  6.24775


rdh_sum =
```

```
                    0.696694661749085

ans =

Berm Factor Calculation: Iteration 1, Profile Segment: 7

dh =

                    5.59575

rdh_sum =

          1.29514584126333

ans =

Berm Factor Calculation: Iteration 1, Profile Segment: 8

dh =

                    5.53985

rdh_sum =

          1.88491919851846

ans =

Berm Factor Calculation: Iteration 1, Profile Segment: 54

dh =

                    -1.58515

rdh_sum =

           1.9125625838384

ans =

Berm Factor Calculation: Iteration 1, Profile Segment: 55

dh =

                    -1.64545

rdh_sum =

          1.94232759962642

ans =

Berm Factor Calculation: Iteration 1, Profile Segment: 56

dh =

                    -1.7051

rdh_sum =

          1.97426609824767

ans =

Berm Factor Calculation: Iteration 1, Profile Segment: 66

dh =

                    -3.51485

rdh_sum =

          2.10529161254412

ans =
```

```
!------- End Berm Factor Calculation, Iter: 1 ---------!

berm_width =

     7

rB =

        0.0801050874192117

rdh_mean =

          0.30075594464916

gamma_berm =

          0.943986993818757

slope =

          0.278155640880075

Irb =

           3.55938219472908

gamma_berm =

          0.943986993818757

gamma_perm =

     1

gamma_beta =

     1

gamma_rough =

                         0.8

gamma =

          0.755189595055005

ans =
!!! - - Iribaren number:   3.36 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!


ans =
!!! - - slope: 1:3.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!


R2_new =

          12.9529669019934

R2del =

          1.95343309800661

Z2 =

          22.6810669019934

ans =
!---------------- STARTING ITERATION 2 ----------------!

Ztoe =

                    2.2749

toe_sta =
```

```
          148.690355329948

top_sta =

          219.673945440751

Z2 =

          22.6810669019934

H0 =

                    4.9688

Tp =

                    13.8709

T0 =

          12.6099090909091

R2 =

          12.9529669019934

Z2 =

          22.6810669019934

top_sta =

          219.673945440751

Lslope =

          70.9835901108023

ans =

Berm Factor Calculation: Iteration 2, Profile Segment: 1

dh =

                    6.24775

rdh_sum =

          0.696694661749085

ans =

Berm Factor Calculation: Iteration 2, Profile Segment: 7

dh =

                    5.59575

rdh_sum =

          1.29514584126333

ans =

Berm Factor Calculation: Iteration 2, Profile Segment: 8

dh =

                    5.53985

rdh_sum =

          1.88491919851846

ans =
```

```
Berm Factor Calculation: Iteration 2, Profile Segment: 54

dh =

                -1.58515

rdh_sum =

        1.92141855805693

ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 55

dh =

                -1.64545

rdh_sum =

        1.96071001201676

ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 56

dh =

                -1.7051

rdh_sum =

        2.00286041802213

ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 66

dh =

                -3.51485

rdh_sum =

        2.17380355043182

ans =
!------- End Berm Factor Calculation, Iter: 2 ---------!

berm_width =
     7

rB =
        0.0986143415551862

rdh_mean =
        0.310543364347402

gamma_berm =
        0.932009687844265

slope =
        0.318928132457954

Irb =
         4.08112203828527

gamma_berm =
        0.932009687844265
```

```
gamma_perm =

     1

gamma_beta =

     1

gamma_rough =

                    0.8

gamma =

        0.745607750275412

ans =
!!! - - Iribaren number:   3.80 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 =

         12.996319619657

R2del =

        0.0433527176635842

Z2 =

         22.724419619657

ans =
!---------------- STARTING ITERATION 3 -----------------!

Ztoe =

                    2.2749

toe_sta =

        148.690355329948

top_sta =

        220.037948107951

Z2 =

         22.724419619657

H0 =

                    4.9688

Tp =

                   13.8709

T0 =

        12.6099090909091

R2 =

         12.996319619657

Z2 =
```

```
          22.724419619657

top_sta =

          220.037948107951

Lslope =

          71.3475927780029

ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 1

dh =

                    6.24775

rdh_sum =

        0.696694661749085

ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 7

dh =

                    5.59575

rdh_sum =

        1.29514584126333

ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 8

dh =

                    5.53985

rdh_sum =

        1.88491919851846

ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 54

dh =

                   -1.58515

rdh_sum =

        1.92117843923054

ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 55

dh =

                   -1.64545

rdh_sum =

        1.96021165551224

ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 56

dh =

                   -1.7051
```

```
rdh_sum =

          2.00208530851954

ans =

Berm Factor Calculation: Iteration 3, Profile Segment: 66

dh =

                -3.51485

rdh_sum =

          2.17195923757907

ans =

!------- End Berm Factor Calculation, Iter: 3 ---------!

berm_width =

     7

rB =

        0.0981112288088038

rdh_mean =

        0.310279891082724

gamma_berm =

        0.932330712579984

slope =

        0.317797740938144

Irb =

         4.06665713138656

gamma_berm =

        0.932330712579984

gamma_perm =

     1

gamma_beta =

     1

gamma_rough =

                    0.8

gamma =

        0.745864570063987

ans =

!!! - - Iribaren number:   3.79 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 =
```

```
        12.9955805204094


R2del =

        0.000739099247571318


Z2 =

          22.7236805204094


% final 2% runup elevation
Z2=R2_new+SWEL

Z2 =

          22.7236805204094


diary off
```