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diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-126-1
% 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-126-1sta_ele_include.csv'; % file with station, elevation, include
% third column is 0 for excluded points
imgname='logfiles/CM-126-1-runup';
SWEL=8.8944; % 100-yr still water level including wave setup.
H0=3.2859; % significant wave height at toe of structure
Tp=11.1501; % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.99698; % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=0.084521;
maxSetup=0.32708; % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-126-1'

plotTitle =

Iterative TAW for CM-126-1

% END CONFIG
%-----

SWEL=SWEL+setupAtToe

SWEL =

8.978921

SWEL_fore=SWEL+maxSetup

SWEL_fore =

9.306001

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

L0 =

525.742714750798

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

% The toe elevation here is only used to determine the average
% structure slope, it is not used to depth limit the wave height.
% Any depth limiting or other modification of the wave height

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% to make it consistent with TAW guidance should be performed
% prior to the input of the significant wave height given above.
Ztoe=SWEL-1.5*H0

Ztoe =

    4.050071

% 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 =

    13.907771

% 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 =

    77.2269642274977

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

top_sta =

    149.955386142946

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

top_sta =

    149.955386142946

toe_sta

toe_sta =

    77.2269642274977

% 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')

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    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 =

!!- The User has selected a starting point that is 0.39 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 4.05 feet elevation, or

ans =

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

% 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;

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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('!!! - - Iribarren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gamma_berm)
    TAW_VALID=0;
else
    sprintf('!!! - - Iribarren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_berm)
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 berm')
    % 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

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        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
    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 =
         4.050071
toe_sta =
       77.2269642274977
top_sta =
      149.955386142946
Z2 =
        13.907771
H0 =
         3.2859
Tp =
        11.1501
T0 =
       10.1364545454545
R2 =
         9.8577
Z2 =
        18.836621
top_sta =
      232.903333838208
Lslope =
       155.67636961071
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 55
dh =
       -4.1887385
rdh_sum =
       0.383155297159985
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    1
rB =
       0.0064235824775503
rdh_mean =
       0.383155297159985
gamma_berm =
       0.996037647175467
slope =
       0.0955966967495737
Irb =
       1.20921171602835

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gamma_berm =
0.996037647175467
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.796830117740374
ans =
!!! - - Iribaren number: 1.20 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:10.5 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
5.60396863461067
R2del =
4.25373136538933
Z2 =
14.5828896346107
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
4.050071
toe_sta =
77.2269642274977
top_sta =
161.317002989022
Z2 =
14.5828896346107
H0 =
3.2859
Tp =
11.1501
T0 =
10.1364545454545
R2 =
5.60396863461067
Z2 =
14.5828896346107
top_sta =
161.317002989022
Lslope =
84.0900387615248
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 55
dh =
-4.1887385
rdh_sum =
0.850719448625709
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
1
rB =
0.011892014972617
rdh_mean =
0.850719448625709
gamma_berm =
0.998224753447936
slope =
0.126763915285209
Irb =
1.60344882976496
gamma_berm =
0.998224753447936
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.798579802758349
ans =
!!! - - Iribaren number: 1.60 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:7.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
7.44733750152237
R2del =
1.8433688669117
Z2 =
16.4262585015224
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
4.050071
toe_sta =
77.2269642274977

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top_sta =
    192.339181459794
Z2 =
    16.4262585015224
H0 =
    3.2859
Tp =
    11.1501
T0 =
    10.1364545454545
R2 =
    7.44733750152237
Z2 =
    16.4262585015224
top_sta =
    192.339181459794
Lslope =
    115.112217232297
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 55
dh =
    -4.1887385
rdh_sum =
    0.597463988351453
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    1
rB =
    0.0086871752107945
rdh_mean =
    0.597463988351453
gamma_berm =
    0.996503099138155
slope =
    0.108456288044323
Irb =
    1.37187391028473
gamma_berm =
    0.996503099138155
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.797202479310524
ans =
!!! - - Iribaren number: 1.37 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:9.2 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
    6.36078104692281
R2del =
    1.08655645459956
Z2 =
    15.3397020469228
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
    4.050071
toe_sta =
    77.2269642274977
top_sta =
    174.053449906983
Z2 =
    15.3397020469228
H0 =
    3.2859
Tp =
    11.1501
T0 =
    10.1364545454545
R2 =
    6.36078104692281
Z2 =
    15.3397020469228
top_sta =
    174.053449906983
Lslope =
    96.8264856794857
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 55
dh =
    -4.1887385
rdh_sum =
    0.738844273826844
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!

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berm_width =
1
rB =
0.0103277527112798
rdh_mean =
0.738844273826844
gamma_berm =
0.997302848240949
slope =
0.117813263909976
Irb =
1.49023118860138
gamma_berm =
0.997302848240949
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.797842278592759
ans =
!!! - - Iribaren number: 1.49 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.5 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
6.91509743027412
R2del =
0.554316383351312
Z2 =
15.8940184302741
ans =
!----- STARTING ITERATION 5 -----!
Ztoe =
4.050071
toe_sta =
77.2269642274977
top_sta =
183.382077552956
Z2 =
15.8940184302741
H0 =
3.2859
Tp =
11.1501
T0 =
10.1364545454545
R2 =
6.91509743027412
Z2 =
15.8940184302741
top_sta =
183.382077552956
Lslope =
106.155113325458
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 55
dh =
-4.1887385
rdh_sum =
0.663054520758695
ans =
!----- End Berm Factor Calculation, Iter: 5 -----!
berm_width =
1
rB =
0.0094201774052478
rdh_mean =
0.663054520758695
gamma_berm =
0.996825913809651
slope =
0.112633109848085
Irb =
1.4247069268282
gamma_berm =
0.996825913809651
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.797460731047721
ans =
!!! - - Iribaren number: 1.42 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.9 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!

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R2_new =
    6.60788461849849
R2del =
    0.307212811775632
Z2 =
    15.5868056184985
ans =
!----- STARTING ITERATION 6 -----!
Ztoe =
    4.050071
toe_sta =
    77.2269642274977
top_sta =
    178.211972509694
Z2 =
    15.5868056184985
H0 =
    3.2859
Tp =
    11.1501
T0 =
    10.1364545454545
R2 =
    6.60788461849849
Z2 =
    15.5868056184985
top_sta =
    178.211972509694
Lslope =
    100.985008282197
ans =
Berm Factor Calculation: Iteration 6, Profile Segment: 55
dh =
    -4.1887385
rdh_sum =
    0.704180489844552
ans =
!----- End Berm Factor Calculation, Iter: 6 -----!
berm_width =
    1
rB =
    0.00990245994935762
rdh_mean =
    0.704180489844552
gamma_berm =
    0.997070659148447
slope =
    0.115384644325251
Irb =
    1.45951134831946
gamma_berm =
    0.997070659148447
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.797656527318758
ans =
!!! - - Iribaren number: 1.46 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.7 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
    6.77097185153569
R2del =
    0.163087233037195
Z2 =
    15.7498928515357
ans =
!----- STARTING ITERATION 7 -----!
Ztoe =
    4.050071
toe_sta =
    77.2269642274977
top_sta =
    180.9565785082
Z2 =
    15.7498928515357
H0 =
    3.2859
Tp =
    11.1501
T0 =
    10.1364545454545
R2 =
    6.77097185153569
Z2 =
    15.7498928515357

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top_sta =
    180.9565785082
Lslope =
    103.729614280702
ans =
Berm Factor Calculation: Iteration 7, Profile Segment: 55
dh =
    -4.1887385
rdh_sum =
    0.682061575075939
ans =
!----- End Berm Factor Calculation, Iter: 7 -----!
berm_width =
    1
rB =
    0.00964044845760156
rdh_mean =
    0.682061575075939
gamma_berm =
    0.996934931001829
slope =
    0.113889475137779
Irb =
    1.44059881095773
gamma_berm =
    0.996934931001829
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.797547944801463
ans =
!!! - - Iribaren number: 1.44 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.8 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
    6.68232295222414
R2del =
    0.0886488993115444
Z2 =
    15.6612439522241
ans =
!----- STARTING ITERATION 8 -----!
Ztoe =
    4.050071
toe_sta =
    77.2269642274977
top_sta =
    179.4647002276
Z2 =
    15.6612439522241
H0 =
    3.2859
Tp =
    11.1501
T0 =
    10.1364545454545
R2 =
    6.68232295222414
Z2 =
    15.6612439522241
top_sta =
    179.4647002276
Lslope =
    102.237736000102
ans =
Berm Factor Calculation: Iteration 8, Profile Segment: 55
dh =
    -4.1887385
rdh_sum =
    0.694006084174838
ans =
!----- End Berm Factor Calculation, Iter: 8 -----!
berm_width =
    1
rB =
    0.00978112426119259
rdh_mean =
    0.694006084174838
gamma_berm =
    0.997007035486145
slope =
    0.114692143571963
Irb =
    1.45075184037927
gamma_berm =
    0.997007035486145

```

```

gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.797605628388916
ans =
!!! - - Iribaren number: 1.45 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.7 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
6.72990523486542
R2del =
0.0475822826412786
Z2 =
15.7088262348654
ans =
!----- STARTING ITERATION 9 -----!
Ztoe =
4.050071
toe_sta =
77.2269642274977
top_sta =
180.265465658025
Z2 =
15.7088262348654
H0 =
3.2859
Tp =
11.1501
T0 =
10.1364545454545
R2 =
6.72990523486542
Z2 =
15.7088262348654
top_sta =
180.265465658025
Lslope =
103.038501430527
ans =
Berm Factor Calculation: Iteration 9, Profile Segment: 55
dh =
-4.1887385
rdh_sum =
0.687571261007195
ans =
!----- End Berm Factor Calculation, Iter: 9 -----!
berm_width =
1
rB =
0.00970511009104926
rdh_mean =
0.687571261007195
gamma_berm =
0.996967844692467
slope =
0.114258393365403
Irb =
1.44526529273239
gamma_berm =
0.996967844692467
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.797574275753974
ans =
!!! - - Iribaren number: 1.44 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.8 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
6.70419009999764
R2del =
0.02571513486778
Z2 =
15.6831110999976
ans =
!----- STARTING ITERATION 10 -----!
Ztoe =
4.050071
toe_sta =
77.2269642274977
top_sta =
179.832703926183

```

```

Z2 =
    15.6831110999976
H0 =
    3.2859
Tp =
    11.1501
T0 =
    10.1364545454545
R2 =
    6.70419009999764
Z2 =
    15.6831110999976
top_sta =
    179.832703926183
Lslope =
    102.605739698685
ans =
Berm Factor Calculation: Iteration 10, Profile Segment: 55
dh =
    -4.1887385
rdh_sum =
    0.691042119918211
ans =
!----- End Berm Factor Calculation, Iter: 10 -----!
berm_width =
    1
rB =
    0.00974604347609237
rdh_mean =
    0.691042119918211
gamma_berm =
    0.996988883068442
slope =
    0.114491958175747
Irb =
    1.44821967624899
gamma_berm =
    0.996988883068442
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.797591106454753
ans =
!!! - - Iribaren number: 1.44 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.7 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
    6.71803643991034
R2del =
    0.0138463399126989
Z2 =
    15.6969574399103
ans =
!----- STARTING ITERATION 11 -----!
Ztoe =
    4.050071
toe_sta =
    77.2269642274977
top_sta =
    180.06572491056
Z2 =
    15.6969574399103
H0 =
    3.2859
Tp =
    11.1501
T0 =
    10.1364545454545
R2 =
    6.71803643991034
Z2 =
    15.6969574399103
top_sta =
    180.06572491056
Lslope =
    102.838760683062
ans =
Berm Factor Calculation: Iteration 11, Profile Segment: 55
dh =
    -4.1887385
rdh_sum =
    0.689171253231771
ans =
!----- End Berm Factor Calculation, Iter: 11 -----!
berm_width =
    1

```

```

rB =
    0.00972396004539463
rdh_mean =
    0.689171253231771
gamma_berm =
    0.996977513685466
slope =
    0.114365948306826
Irb =
    1.44662576542346
gamma_berm =
    0.996977513685466
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.797582010948373
ans =
!!! - - Iribaren number: 1.44 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:8.7 V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!
R2_new =
    6.71056604155056
R2del =
    0.0074703983597777
Z2 =
    15.6894870415506
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
    15.6894870415506
diary off
-1.000000e+00
-1.000000e+00
-1.000000e+00

```