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diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-130
% 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-130sta_ele_include.csv'; % file with station, elevation, include
                                         % third column is 0 for excluded points
imgname='logfiles/CM-130-runup';
SWEL=8.8141; % 100-yr still water level including wave setup.
H0=7.5866; % significant wave height at toe of structure
Tp=13.6829; % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.804; % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=0.01352;
maxSetup=0.36725; % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-130'

plotTitle =

Iterative TAW for CM-130

% END CONFIG
%-----

SWEL=SWEL+setupAtToe

SWEL =

8.82762

SWEL_fore=SWEL+maxSetup

SWEL_fore =

9.19487

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

L0 =

791.720781251791

% 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 =

        -2.55228

% 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 =

        20.20752

% 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 =

        -33.240149937526

% 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
top_sta =

        94.8165933792417

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

top_sta =

        94.8165933792417

toe_sta

toe_sta =

        -33.240149937526

% 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 =

-!!!- Location of SWEL-1.5*H0 is 111.9 ft landward of toe of slope

ans =

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

ans =

-!!!-      setup is adjusted to 0.07 feet

ans =

-!!!-      SWEL is adjusted to 8.88 feet

k =

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

% 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

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        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
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('!!! - - 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

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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
        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 =
    -2.55228
toe_sta =
    -33.240149937526
top_sta =
    94.8165933792417
Z2 =
    20.20752
H0 =
    7.5866
Tp =
    13.6829
T0 =
    12.439
R2 =
    22.7598
Z2 =
    31.6403931983369
top_sta =
    113.787593459449
Lslope =
    147.027743396975
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 9
dh =
    10.4638181983369

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```
rdh_sum =
    0.780553558669201
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 10
dh =
    10.4164681983369
rdh_sum =
    1.55703620551544
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 15
dh =
    9.9994431983369
rdh_sum =
    2.29656225114538
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 16
dh =
    9.9955431983369
rdh_sum =
    3.03573381700501
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 17
dh =
    9.9750181983369
rdh_sum =
    3.77303725482285
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 18
dh =
    9.9378681983369
rdh_sum =
    4.50694852841179
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 29
dh =
    8.9619181983369
rdh_sum =
    5.14741036178807
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 30
dh =
    8.9367681983369
rdh_sum =
    5.78537151393999
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 31
dh =
    8.9202181983369
rdh_sum =
    6.42168504354656
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 32
dh =
    8.9122681983369
rdh_sum =
    7.05720654671662
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 35
dh =
    8.7052181983369
rdh_sum =
    7.67197751094222
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 36
dh =
    8.6460681983369
rdh_sum =
    8.28078005843578
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 37
dh =
    8.6078431983369
rdh_sum =
    8.88571684926343
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 38
dh =
    8.5905431983369
rdh_sum =
    9.48890188770133
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 39
dh =
    8.5871181983369
rdh_sum =
    10.0917399619611
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 40
dh =
    8.5975681983369
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rdh_sum =
    10.6956364942951
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 41
dh =
    8.5782931983369
rdh_sum =
    11.2975803280897
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 42
dh =
    8.5292931983369
rdh_sum =
    11.8945528651283
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 43
dh =
    8.4775681983369
rdh_sum =
    12.4862668215186
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 44
dh =
    8.4231181983369
rdh_sum =
    13.0724338088691
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 45
dh =
    8.3779431983369
rdh_sum =
    13.6539903539078
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 46
dh =
    8.3420431983369
rdh_sum =
    14.2318779311088
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 55
dh =
    7.0645431983369
rdh_sum =
    14.6779368840052
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 56
dh =
    7.0462431983369
rdh_sum =
    15.1221127906567
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 57
dh =
    7.0251431983369
rdh_sum =
    15.5641185311599
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 58
dh =
    7.0012431983369
rdh_sum =
    16.0036674605257
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 59
dh =
    6.9773431983369
rdh_sum =
    16.4407610590331
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 60
dh =
    6.9534431983369
rdh_sum =
    16.8754008670852
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 61
dh =
    6.9421431983369
rdh_sum =
    17.3088810683691
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 62
dh =
    6.9434431983369
rdh_sum =
    17.7424946573258
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 63
dh =
    6.9481931983369
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```
rdh_sum =
    18.1765956651373
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 64
dh =
    6.9563931983369
rdh_sum =
    18.6115382615405
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 75
dh =
    5.4143681983369
rdh_sum =
    18.8941640468532
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 76
dh =
    5.3887181983369
rdh_sum =
    19.1744015846377
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 77
dh =
    5.3816431983369
rdh_sum =
    19.453981463547
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 78
dh =
    5.3931431983369
rdh_sum =
    19.7346305684097
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 79
dh =
    5.6787431983369
rdh_sum =
    20.0422170458552
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 80
dh =
    6.2384431983369
rdh_sum =
    20.4044547752253
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 85
dh =
    3.2302181983369
rdh_sum =
    20.5121754135587
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 86
dh =
    4.7024681983369
rdh_sum =
    20.7310286080316
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 87
dh =
    5.4587181983369
rdh_sum =
    21.0177982065128
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 88
dh =
    5.4989681983369
rdh_sum =
    21.3083441098315
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 89
dh =
    5.5417181983369
rdh_sum =
    21.6029167950983
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 90
dh =
    5.5869681983369
rdh_sum =
    21.9017692735243
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 91
dh =
    5.5918931983369
rdh_sum =
    22.201088635858
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 92
dh =
    5.5564931983369
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rdh_sum =
    22.4970567919556
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 95
dh =
    0.860243198336903
rdh_sum =
    22.5049668326762
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 96
dh =
    3.7329431983369
rdh_sum =
    22.6470226491222
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 97
dh =
    5.1387681983369
rdh_sum =
    22.9043222638872
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 98
dh =
    5.0777181983369
rdh_sum =
    23.1561157517155
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    50
rB =
    0.340071872456071
rdh_mean =
    0.46312231503431
gamma_berm =
    0.817423000393837
slope =
    0.352400993790431
Irb =
    3.59997556846645
gamma_berm =
    0.817423000393837
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.65393840031507
ans =
!!! - Iribaren number: 2.94 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - slope: 1:2.8 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    17.1493876990298
R2del =
    5.61041230097024
Z2 =
    26.0299808973667
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
    -2.55228
toe_sta =
    -33.240149937526
top_sta =
    104.478023558229
Z2 =
    26.0299808973667
H0 =
    7.5866
Tp =
    13.6829
T0 =
    12.439
R2 =
    17.1493876990298
Z2 =
    26.0299808973667
top_sta =
    104.478023558229
Lslope =
    137.718173495755
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 9
dh =
    10.4638181983369
rdh_sum =
    0.780553558669201

```

```
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 10  
dh =  
    10.4164681983369  
rdh_sum =  
    1.55703620551544  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 15  
dh =  
    9.9994431983369  
rdh_sum =  
    2.29656225114538  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 16  
dh =  
    9.9955431983369  
rdh_sum =  
    3.03573381700501  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 17  
dh =  
    9.9750181983369  
rdh_sum =  
    3.77303725482285  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 18  
dh =  
    9.9378681983369  
rdh_sum =  
    4.50694852841179  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 29  
dh =  
    8.9619181983369  
rdh_sum =  
    5.14741036178807  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 30  
dh =  
    8.9367681983369  
rdh_sum =  
    5.78537151393999  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 31  
dh =  
    8.9202181983369  
rdh_sum =  
    6.42168504354656  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 32  
dh =  
    8.9122681983369  
rdh_sum =  
    7.05720654671662  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 35  
dh =  
    8.7052181983369  
rdh_sum =  
    7.67197751094222  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 36  
dh =  
    8.6460681983369  
rdh_sum =  
    8.28078005843578  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 37  
dh =  
    8.6078431983369  
rdh_sum =  
    8.88571684926343  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 38  
dh =  
    8.5905431983369  
rdh_sum =  
    9.48890188770133  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 39  
dh =  
    8.5871181983369  
rdh_sum =  
    10.0917399619611  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 40  
dh =  
    8.5975681983369  
rdh_sum =  
    10.6956364942951
```

```
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 41  
dh =  
    8.5782931983369  
rdh_sum =  
    11.2975803280897  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 42  
dh =  
    8.5292931983369  
rdh_sum =  
    11.8945528651283  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 43  
dh =  
    8.4775681983369  
rdh_sum =  
    12.4862668215186  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 44  
dh =  
    8.4231181983369  
rdh_sum =  
    13.0724338088691  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 45  
dh =  
    8.3779431983369  
rdh_sum =  
    13.6539903539078  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 46  
dh =  
    8.3420431983369  
rdh_sum =  
    14.2318779311088  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 55  
dh =  
    7.0645431983369  
rdh_sum =  
    14.6779368840052  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 56  
dh =  
    7.0462431983369  
rdh_sum =  
    15.1221127906567  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 57  
dh =  
    7.0251431983369  
rdh_sum =  
    15.5641185311599  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 58  
dh =  
    7.0012431983369  
rdh_sum =  
    16.0036674605257  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 59  
dh =  
    6.9773431983369  
rdh_sum =  
    16.4407610590331  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 60  
dh =  
    6.9534431983369  
rdh_sum =  
    16.8754008670852  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 61  
dh =  
    6.9421431983369  
rdh_sum =  
    17.3088810683691  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 62  
dh =  
    6.9434431983369  
rdh_sum =  
    17.7424946573258  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 63  
dh =  
    6.9481931983369  
rdh_sum =  
    18.1765956651373
```

```
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 64  
dh =  
    6.9563931983369  
rdh_sum =  
    18.6115382615405  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 75  
dh =  
    5.4143681983369  
rdh_sum =  
    18.8941640468532  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 76  
dh =  
    5.3887181983369  
rdh_sum =  
    19.1744015846377  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 77  
dh =  
    5.3816431983369  
rdh_sum =  
    19.453981463547  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 78  
dh =  
    5.3931431983369  
rdh_sum =  
    19.7346305684097  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 79  
dh =  
    5.6787431983369  
rdh_sum =  
    20.0422170458552  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 80  
dh =  
    6.2384431983369  
rdh_sum =  
    20.4044547752253  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 85  
dh =  
    3.2302181983369  
rdh_sum =  
    20.5121754135587  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 86  
dh =  
    4.7024681983369  
rdh_sum =  
    20.7310286080316  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 87  
dh =  
    5.4587181983369  
rdh_sum =  
    21.0177982065128  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 88  
dh =  
    5.4989681983369  
rdh_sum =  
    21.3083441098315  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 89  
dh =  
    5.5417181983369  
rdh_sum =  
    21.6029167950983  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 90  
dh =  
    5.5869681983369  
rdh_sum =  
    21.9017692735243  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 91  
dh =  
    5.5918931983369  
rdh_sum =  
    22.201088635858  
ans =  
Berm Factor Calculation: Iteration 2, Profile Segment: 92  
dh =  
    5.5564931983369  
rdh_sum =  
    22.4970567919556
```

```

ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 95
dh =
    0.860243198336903
rdh_sum =
    22.5049668326762
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 96
dh =
    3.7329431983369
rdh_sum =
    22.6470226491222
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 97
dh =
    5.1387681983369
rdh_sum =
    22.9043222638872
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 98
dh =
    5.0777181983369
rdh_sum =
    23.1561157517155
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    50
rB =
    0.363060289944531
rdh_mean =
    0.46312231503431
gamma_berm =
    0.805081032031608
slope =
    0.325841952223844
Irb =
    3.32865992961653
gamma_berm =
    0.805081032031608
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.644064825625287
ans =
!!! - - Iribaren number: 2.68 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 =
    16.7258168733221
R2del =
    0.423570825707621
Z2 =
    25.606410071659
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
    -2.55228
toe_sta =
    -33.240149937526
top_sta =
    103.775176423561
Z2 =
    25.606410071659
H0 =
    7.5866
Tp =
    13.6829
T0 =
    12.439
R2 =
    16.7258168733221
Z2 =
    25.606410071659
top_sta =
    103.775176423561
Lslope =
    137.015326361087
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 9
dh =
    10.4638181983369
rdh_sum =
    0.780553558669201
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 10

```

```
dh =
    10.4164681983369
rdh_sum =
    1.55703620551544
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 15
dh =
    9.9994431983369
rdh_sum =
    2.29656225114538
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 16
dh =
    9.9955431983369
rdh_sum =
    3.03573381700501
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 17
dh =
    9.9750181983369
rdh_sum =
    3.77303725482285
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 18
dh =
    9.9378681983369
rdh_sum =
    4.50694852841179
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 29
dh =
    8.9619181983369
rdh_sum =
    5.14741036178807
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 30
dh =
    8.9367681983369
rdh_sum =
    5.78537151393999
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 31
dh =
    8.9202181983369
rdh_sum =
    6.42168504354656
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 32
dh =
    8.9122681983369
rdh_sum =
    7.05720654671662
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 35
dh =
    8.7052181983369
rdh_sum =
    7.67197751094222
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 36
dh =
    8.6460681983369
rdh_sum =
    8.28078005843578
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 37
dh =
    8.6078431983369
rdh_sum =
    8.88571684926343
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 38
dh =
    8.5905431983369
rdh_sum =
    9.48890188770133
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 39
dh =
    8.5871181983369
rdh_sum =
    10.0917399619611
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 40
dh =
    8.5975681983369
rdh_sum =
    10.6956364942951
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 41
```

```
dh =
      8.5782931983369
rdh_sum =
      11.2975803280897
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 42
dh =
      8.5292931983369
rdh_sum =
      11.8945528651283
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 43
dh =
      8.4775681983369
rdh_sum =
      12.4862668215186
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 44
dh =
      8.4231181983369
rdh_sum =
      13.0724338088691
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 45
dh =
      8.3779431983369
rdh_sum =
      13.6539903539078
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 46
dh =
      8.3420431983369
rdh_sum =
      14.2318779311088
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 55
dh =
      7.0645431983369
rdh_sum =
      14.6779368840052
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 56
dh =
      7.0462431983369
rdh_sum =
      15.1221127906567
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 57
dh =
      7.0251431983369
rdh_sum =
      15.5641185311599
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 58
dh =
      7.0012431983369
rdh_sum =
      16.0036674605257
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 59
dh =
      6.9773431983369
rdh_sum =
      16.4407610590331
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 60
dh =
      6.9534431983369
rdh_sum =
      16.8754008670852
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 61
dh =
      6.9421431983369
rdh_sum =
      17.3088810683691
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 62
dh =
      6.9434431983369
rdh_sum =
      17.7424946573258
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 63
dh =
      6.9481931983369
rdh_sum =
      18.1765956651373
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 64
```

```
dh =
    6.9563931983369
rdh_sum =
    18.6115382615405
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 75
dh =
    5.4143681983369
rdh_sum =
    18.8941640468532
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 76
dh =
    5.3887181983369
rdh_sum =
    19.1744015846377
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 77
dh =
    5.3816431983369
rdh_sum =
    19.453981463547
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 78
dh =
    5.3931431983369
rdh_sum =
    19.7346305684097
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 79
dh =
    5.6787431983369
rdh_sum =
    20.0422170458552
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 80
dh =
    6.2384431983369
rdh_sum =
    20.4044547752253
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 85
dh =
    3.2302181983369
rdh_sum =
    20.5121754135587
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 86
dh =
    4.7024681983369
rdh_sum =
    20.7310286080316
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 87
dh =
    5.4587181983369
rdh_sum =
    21.0177982065128
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 88
dh =
    5.4989681983369
rdh_sum =
    21.3083441098315
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 89
dh =
    5.5417181983369
rdh_sum =
    21.6029167950983
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 90
dh =
    5.5869681983369
rdh_sum =
    21.9017692735243
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 91
dh =
    5.5918931983369
rdh_sum =
    22.201088635858
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 92
dh =
    5.5564931983369
rdh_sum =
    22.4970567919556
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 95
```



```

dh =
    0.860243198336903
rdh_sum =
    22.5049668326762
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 96
dh =
    3.7329431983369
rdh_sum =
    22.6470226491222
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 97
dh =
    5.1387681983369
rdh_sum =
    22.9043222638872
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 98
dh =
    5.0777181983369
rdh_sum =
    23.1561157517155
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    50
rB =
    0.364922679293783
rdh_mean =
    0.46312231503431
gamma_berm =
    0.804081156749277
slope =
    0.323606096181368
Irb =
    3.305819394915
gamma_berm =
    0.804081156749277
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.643264925399421
ans =
!!! - - Iribaren number: 2.66 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 =
    16.6902846566313
R2del =
    0.0355322166908394
Z2 =
    25.5708778549682
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
    -2.55228
toe_sta =
    -33.240149937526
top_sta =
    103.716216468876
Z2 =
    25.5708778549682
H0 =
    7.5866
Tp =
    13.6829
T0 =
    12.439
R2 =
    16.6902846566313
Z2 =
    25.5708778549682
top_sta =
    103.716216468876
Lslope =
    136.956366406402
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 9
dh =
    10.4638181983369
rdh_sum =
    0.780553558669201
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 10
dh =
    10.4164681983369

```

```
rdh_sum =
    1.55703620551544
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 15
dh =
    9.9994431983369
rdh_sum =
    2.29656225114538
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 16
dh =
    9.9955431983369
rdh_sum =
    3.03573381700501
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 17
dh =
    9.9750181983369
rdh_sum =
    3.77303725482285
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 18
dh =
    9.9378681983369
rdh_sum =
    4.50694852841179
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 29
dh =
    8.9619181983369
rdh_sum =
    5.14741036178807
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 30
dh =
    8.9367681983369
rdh_sum =
    5.78537151393999
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 31
dh =
    8.9202181983369
rdh_sum =
    6.42168504354656
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 32
dh =
    8.9122681983369
rdh_sum =
    7.05720654671662
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 35
dh =
    8.7052181983369
rdh_sum =
    7.67197751094222
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 36
dh =
    8.6460681983369
rdh_sum =
    8.28078005843578
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 37
dh =
    8.6078431983369
rdh_sum =
    8.88571684926343
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 38
dh =
    8.5905431983369
rdh_sum =
    9.48890188770133
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 39
dh =
    8.5871181983369
rdh_sum =
    10.0917399619611
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 40
dh =
    8.5975681983369
rdh_sum =
    10.6956364942951
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 41
dh =
    8.5782931983369
```

```
rdh_sum =
    11.2975803280897
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 42
dh =
    8.5292931983369
rdh_sum =
    11.8945528651283
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 43
dh =
    8.4775681983369
rdh_sum =
    12.4862668215186
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 44
dh =
    8.4231181983369
rdh_sum =
    13.0724338088691
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 45
dh =
    8.3779431983369
rdh_sum =
    13.6539903539078
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 46
dh =
    8.3420431983369
rdh_sum =
    14.2318779311088
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 55
dh =
    7.0645431983369
rdh_sum =
    14.6779368840052
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 56
dh =
    7.0462431983369
rdh_sum =
    15.1221127906567
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 57
dh =
    7.0251431983369
rdh_sum =
    15.5641185311599
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 58
dh =
    7.0012431983369
rdh_sum =
    16.0036674605257
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 59
dh =
    6.9773431983369
rdh_sum =
    16.4407610590331
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 60
dh =
    6.9534431983369
rdh_sum =
    16.8754008670852
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 61
dh =
    6.9421431983369
rdh_sum =
    17.3088810683691
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 62
dh =
    6.9434431983369
rdh_sum =
    17.7424946573258
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 63
dh =
    6.9481931983369
rdh_sum =
    18.1765956651373
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 64
dh =
    6.9563931983369
```

```
rdh_sum =
    18.6115382615405
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 75
dh =
    5.4143681983369
rdh_sum =
    18.8941640468532
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 76
dh =
    5.3887181983369
rdh_sum =
    19.1744015846377
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 77
dh =
    5.3816431983369
rdh_sum =
    19.453981463547
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 78
dh =
    5.3931431983369
rdh_sum =
    19.7346305684097
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 79
dh =
    5.6787431983369
rdh_sum =
    20.0422170458552
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 80
dh =
    6.2384431983369
rdh_sum =
    20.4044547752253
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 85
dh =
    3.2302181983369
rdh_sum =
    20.5121754135587
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 86
dh =
    4.7024681983369
rdh_sum =
    20.7310286080316
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 87
dh =
    5.4587181983369
rdh_sum =
    21.0177982065128
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 88
dh =
    5.4989681983369
rdh_sum =
    21.3083441098315
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 89
dh =
    5.5417181983369
rdh_sum =
    21.6029167950983
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 90
dh =
    5.5869681983369
rdh_sum =
    21.9017692735243
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 91
dh =
    5.5918931983369
rdh_sum =
    22.201088635858
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 92
dh =
    5.5564931983369
rdh_sum =
    22.4970567919556
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 95
dh =
    0.860243198336903
```

```

rdh_sum =
    22.5049668326762
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 96
dh =
    3.7329431983369
rdh_sum =
    22.6470226491222
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 97
dh =
    5.1387681983369
rdh_sum =
    22.9043222638872
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 98
dh =
    5.0777181983369
rdh_sum =
    23.1561157517155
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    50
rB =
    0.365079779143898
rdh_mean =
    0.46312231503431
gamma_berm =
    0.803996813345439
slope =
    0.323416893060261
Irb =
    3.30388657796651
gamma_berm =
    0.803996813345439
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.643197450676351
ans =
!!! - - Iribaren number: 2.66 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 =
    16.6872780754554
R2del =
    0.00300658117590658
Z2 =
    25.5678712737923
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
    25.5678712737923
diary off
-1.000000e+00
-1.000000e+00
-1.000000e+00

```