

```

diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-138
% 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-138sta_ele_include.csv'; % file with station, elevation, include
                                         % third column is 0 for excluded points
imgname='logfiles/CM-138-runup';
SWEL=8.7974; % 100-yr still water level including wave setup.
H0=8.8182; % significant wave height at toe of structure
Tp=11.5883; % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.7418; % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=0.14678;
maxSetup=1.2538; % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-138'

plotTitle =

Iterative TAW for CM-138

% END CONFIG
%-----

SWEL=SWEL+setupAtToe

SWEL =

8.94418

SWEL_fore=SWEL+maxSetup

SWEL_fore =

10.19798

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

L0 =

567.878201365222

% 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 =

        -4.28312

% 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 =

        22.17148

% 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 =

        -12.6070531009323

% 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 =

        193.621588415972

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

top_sta =

        193.621588415972

toe_sta

toe_sta =

        -12.6070531009323

% 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 144.2 ft landward of toe of slope

ans =

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

ans =

-!!-          setup is adjusted to 0.19 feet

ans =

-!!-          SWEL is adjusted to 8.99 feet

k =

    1
    2
    3
    4
    5
    6

% 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

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% 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

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')
end

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% 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 =
    -4.28312
toe_sta =
    -12.6070531009323
top_sta =
    193.621588415972
Z2 =
    22.17148
H0 =
    8.8182
Tp =
    11.5883
T0 =
    10.5348181818182
R2 =
    26.4546
Z2 =
    35.4401722012379
top_sta =
    310.064696807706
Lslope =
    322.671749908638
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 17
dh =
    6.29127220123795
rdh_sum =
    0.282460702628984
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 18
dh =
    6.22707220123795
rdh_sum =
    0.559787292980458
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 19

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```
dh =
    6.16412220123795
rdh_sum =
    0.832108006534625
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 20
dh =
    6.10242220123795
rdh_sum =
    1.09955002195992
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 21
dh =
    6.09154720123795
rdh_sum =
    1.36613503247288
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 22
dh =
    6.13149720123795
rdh_sum =
    1.63587258153965
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 23
dh =
    6.25207220123795
rdh_sum =
    1.91519501158891
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 24
dh =
    6.45327220123795
rdh_sum =
    2.21073589632493
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 31
dh =
    5.76017220123795
rdh_sum =
    2.4516418958307
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 32
dh =
    5.80497220123795
rdh_sum =
    2.69596873894072
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 33
dh =
    5.84559720123795
rdh_sum =
    2.94341171339809
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 34
dh =
    5.88204720123795
rdh_sum =
    3.19366183842669
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 45
dh =
    4.93314720123795
rdh_sum =
    3.37460348110133
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 46
dh =
    4.87929720123795
rdh_sum =
    3.55186709163431
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 47
dh =
    4.86907220123795
rdh_sum =
    3.72843566437936
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 48
dh =
    4.90247220123795
rdh_sum =
    3.90727854035513
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 49
dh =
    4.89889720123795
rdh_sum =
    4.08587743947292
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 50
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```
dh =
    4.85834720123795
rdh_sum =
    4.26171814024804
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 51
dh =
    4.82419720123795
rdh_sum =
    4.43524908232813
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 52
dh =
    4.79644720123795
rdh_sum =
    4.60691202718651
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 53
dh =
    4.78844720123795
rdh_sum =
    4.77803793813875
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 54
dh =
    4.80019720123795
rdh_sum =
    4.94995284723646
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 55
dh =
    4.81194720123795
rdh_sum =
    5.12265819175903
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 56
dh =
    4.82369720123795
rdh_sum =
    5.29615540552312
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 57
dh =
    4.83544720123795
rdh_sum =
    5.47044591887635
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 58
dh =
    4.84719720123795
rdh_sum =
    5.64553115869104
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 59
dh =
    4.85894720123795
rdh_sum =
    5.82141254835796
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 60
dh =
    4.87069720123795
rdh_sum =
    5.99809150778011
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 65
dh =
    4.41112220123795
rdh_sum =
    6.14466526135442
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 66
dh =
    4.35622220123795
rdh_sum =
    6.28779718957001
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 73
dh =
    3.17299720123795
rdh_sum =
    6.36555891436826
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 74
dh =
    3.24044720123795
rdh_sum =
    6.44656859367674
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 75
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```
dh =
    3.30857220123795
rdh_sum =
    6.53092012465246
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 76
dh =
    3.37737220123795
rdh_sum =
    6.61870873893987
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 77
dh =
    3.38909720123795
rdh_sum =
    6.70708929511508
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 78
dh =
    3.34374720123795
rdh_sum =
    6.79319031767134
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 87
dh =
    2.76949720123795
rdh_sum =
    6.85281072388137
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 88
dh =
    2.91034720123795
rdh_sum =
    6.91850991561035
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 89
dh =
    2.95689720123795
rdh_sum =
    6.98627840311864
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 90
dh =
    2.90914720123795
rdh_sum =
    7.05192464523216
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 91
dh =
    2.85632220123795
rdh_sum =
    7.11525970187625
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 92
dh =
    2.79842220123795
rdh_sum =
    7.17610595427901
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 93
dh =
    2.74052220123795
rdh_sum =
    7.23451011664972
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 94
dh =
    2.68262220123795
rdh_sum =
    7.29051916297073
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 95
dh =
    2.62472220123795
rdh_sum =
    7.34418032200063
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 96
dh =
    2.56682220123795
rdh_sum =
    7.39554107225041
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 97
dh =
    2.50894720123795
rdh_sum =
    7.44465009926203
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 98
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dh =
    2.45109720123795
rdh_sum =
    7.49155626594893
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 103
dh =
    2.10582220123795
rdh_sum =
    7.52632301791203
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 104
dh =
    2.11492220123795
rdh_sum =
    7.56138732811712
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 105
dh =
    2.13012220123795
rdh_sum =
    7.59695138282257
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 106
dh =
    2.15142220123795
rdh_sum =
    7.63322146514012
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 107
dh =
    2.17274720123795
rdh_sum =
    7.67020509128851
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 108
dh =
    2.19409720123795
rdh_sum =
    7.70790979070597
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 109
dh =
    2.21544720123795
rdh_sum =
    7.74634224981549
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 110
dh =
    2.23679720123795
rdh_sum =
    7.78550914451404
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 111
dh =
    2.26077220123795
rdh_sum =
    7.82550871864173
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 112
dh =
    2.28737220123795
rdh_sum =
    7.86644195885277
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 113
dh =
    2.34167220123795
rdh_sum =
    7.90931311293609
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 114
dh =
    2.42367220123795
rdh_sum =
    7.95519176489019
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 129
dh =
    1.09154720123795
rdh_sum =
    7.96461359987917
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 130
dh =
    1.06909720123795
rdh_sum =
    7.97365302009818
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
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berm_width =
62
rB =
0.192145733295694
rdh_mean =
0.128607306775777
gamma_berm =
0.832565611971922
slope =
0.152388174841196
Irb =
1.22289422562323
gamma_berm =
0.832565611971922
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.666052489577538
ans =
!!! - - Iribaren number: 1.02 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:6.6 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
12.7130735975359
R2del =
13.7415264024641
Z2 =
21.6986457987738
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
-4.28312
toe_sta =
-12.6070531009323
top_sta =
189.472100033119
Z2 =
21.6986457987738
H0 =
8.8182
Tp =
11.5883
T0 =
10.5348181818182
R2 =
12.7130735975359
Z2 =
21.6986457987738
top_sta =
189.472100033119
Lslope =
202.079153134051
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 17
dh =
6.29127220123795
rdh_sum =
0.282460702628984
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 18
dh =
6.22707220123795
rdh_sum =
0.559787292980458
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 19
dh =
6.16412220123795
rdh_sum =
0.832108006534625
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 20
dh =
6.10242220123795
rdh_sum =
1.09955002195992
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 21
dh =
6.09154720123795
rdh_sum =
1.36613503247288
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 22
dh =
6.13149720123795

```

```
rdh_sum =
    1.63587258153965
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 23
dh =
    6.25207220123795
rdh_sum =
    1.91519501158891
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 24
dh =
    6.45327220123795
rdh_sum =
    2.21073589632493
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 31
dh =
    5.76017220123795
rdh_sum =
    2.4516418958307
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 32
dh =
    5.80497220123795
rdh_sum =
    2.69596873894072
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 33
dh =
    5.84559720123795
rdh_sum =
    2.94341171339809
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 34
dh =
    5.88204720123795
rdh_sum =
    3.19366183842669
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 45
dh =
    4.93314720123795
rdh_sum =
    3.37460348110133
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 46
dh =
    4.87929720123795
rdh_sum =
    3.55186709163431
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 47
dh =
    4.86907220123795
rdh_sum =
    3.72843566437936
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 48
dh =
    4.90247220123795
rdh_sum =
    3.90727854035513
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 49
dh =
    4.89889720123795
rdh_sum =
    4.08587743947292
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 50
dh =
    4.85834720123795
rdh_sum =
    4.26171814024804
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 51
dh =
    4.82419720123795
rdh_sum =
    4.43524908232813
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 52
dh =
    4.79644720123795
rdh_sum =
    4.60691202718651
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 53
dh =
    4.78844720123795
```

```
rdh_sum =
    4.77803793813875
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 54
dh =
    4.80019720123795
rdh_sum =
    4.94995284723646
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 55
dh =
    4.81194720123795
rdh_sum =
    5.12265819175903
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 56
dh =
    4.82369720123795
rdh_sum =
    5.29615540552312
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 57
dh =
    4.83544720123795
rdh_sum =
    5.47044591887635
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 58
dh =
    4.84719720123795
rdh_sum =
    5.64553115869104
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 59
dh =
    4.85894720123795
rdh_sum =
    5.82141254835796
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 60
dh =
    4.87069720123795
rdh_sum =
    5.99809150778011
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 65
dh =
    4.41112220123795
rdh_sum =
    6.14466526135442
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 66
dh =
    4.35622220123795
rdh_sum =
    6.28779718957001
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 73
dh =
    3.17299720123795
rdh_sum =
    6.36555891436826
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 74
dh =
    3.24044720123795
rdh_sum =
    6.44656859367674
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 75
dh =
    3.30857220123795
rdh_sum =
    6.53092012465246
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 76
dh =
    3.37737220123795
rdh_sum =
    6.61870873893987
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 77
dh =
    3.38909720123795
rdh_sum =
    6.70708929511508
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 78
dh =
    3.34374720123795
```

```
rdh_sum =
    6.79319031767134
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 87
dh =
    2.76949720123795
rdh_sum =
    6.85281072388137
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 88
dh =
    2.91034720123795
rdh_sum =
    6.91850991561035
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 89
dh =
    2.95689720123795
rdh_sum =
    6.98627840311864
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 90
dh =
    2.90914720123795
rdh_sum =
    7.05192464523216
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 91
dh =
    2.85632220123795
rdh_sum =
    7.11525970187625
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 92
dh =
    2.79842220123795
rdh_sum =
    7.17610595427901
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 93
dh =
    2.74052220123795
rdh_sum =
    7.23451011664972
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 94
dh =
    2.68262220123795
rdh_sum =
    7.29051916297073
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 95
dh =
    2.62472220123795
rdh_sum =
    7.34418032200063
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 96
dh =
    2.56682220123795
rdh_sum =
    7.39554107225041
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 97
dh =
    2.50894720123795
rdh_sum =
    7.44465009926203
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 98
dh =
    2.45109720123795
rdh_sum =
    7.49155626594893
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 103
dh =
    2.10582220123795
rdh_sum =
    7.52632301791203
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 104
dh =
    2.11492220123795
rdh_sum =
    7.56138732811712
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 105
dh =
    2.13012220123795
```

```

rdh_sum =
    7.59695138282257
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 106
dh =
    2.15142220123795
rdh_sum =
    7.63322146514012
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 107
dh =
    2.17274720123795
rdh_sum =
    7.67020509128851
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 108
dh =
    2.19409720123795
rdh_sum =
    7.70790979070597
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 109
dh =
    2.21544720123795
rdh_sum =
    7.74634224981549
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 110
dh =
    2.23679720123795
rdh_sum =
    7.78550914451404
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 111
dh =
    2.26077220123795
rdh_sum =
    7.82550871864173
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 112
dh =
    2.28737220123795
rdh_sum =
    7.86644195885277
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 113
dh =
    2.34167220123795
rdh_sum =
    7.90931311293609
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 114
dh =
    2.42367220123795
rdh_sum =
    7.95519176489019
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 129
dh =
    1.09154720123795
rdh_sum =
    7.96461359987917
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 130
dh =
    1.06909720123795
rdh_sum =
    7.97365302009818
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    62
rB =
    0.306810470246141
rdh_mean =
    0.128607306775777
gamma_berm =
    0.732647598022825
slope =
    0.18547917529106
Irb =
    1.48844497070175
gamma_berm =
    0.732647598022825
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =

```

```

gamma =
    0.58611807841826
ans =
!!! - - Iribaren number:    1.09 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.4 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    13.6166762251337
R2del =
    0.903602627597804
Z2 =
    22.6022484263716
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
    -4.28312
toe_sta =
    -12.6070531009323
top_sta =
    197.401916861533
Z2 =
    22.6022484263716
H0 =
    8.8182
Tp =
    11.5883
T0 =
    10.5348181818182
R2 =
    13.6166762251337
Z2 =
    22.6022484263716
top_sta =
    197.401916861533
Lslope =
    210.008969962465
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 17
dh =
    6.29127220123795
rdh_sum =
    0.282460702628984
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 18
dh =
    6.22707220123795
rdh_sum =
    0.559787292980458
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 19
dh =
    6.16412220123795
rdh_sum =
    0.832108006534625
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 20
dh =
    6.10242220123795
rdh_sum =
    1.09955002195992
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 21
dh =
    6.09154720123795
rdh_sum =
    1.36613503247288
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 22
dh =
    6.13149720123795
rdh_sum =
    1.63587258153965
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 23
dh =
    6.25207220123795
rdh_sum =
    1.91519501158891
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 24
dh =
    6.45327220123795
rdh_sum =
    2.21073589632493
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 31
dh =
    5.76017220123795
rdh_sum =
    2.4516418958307

```

```
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 32  
dh =  
    5.80497220123795  
rdh_sum =  
    2.69596873894072  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 33  
dh =  
    5.84559720123795  
rdh_sum =  
    2.94341171339809  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 34  
dh =  
    5.88204720123795  
rdh_sum =  
    3.19366183842669  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 45  
dh =  
    4.93314720123795  
rdh_sum =  
    3.37460348110133  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 46  
dh =  
    4.87929720123795  
rdh_sum =  
    3.55186709163431  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 47  
dh =  
    4.86907220123795  
rdh_sum =  
    3.72843566437936  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 48  
dh =  
    4.90247220123795  
rdh_sum =  
    3.90727854035513  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 49  
dh =  
    4.89889720123795  
rdh_sum =  
    4.08587743947292  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 50  
dh =  
    4.85834720123795  
rdh_sum =  
    4.26171814024804  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 51  
dh =  
    4.82419720123795  
rdh_sum =  
    4.43524908232813  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 52  
dh =  
    4.79644720123795  
rdh_sum =  
    4.60691202718651  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 53  
dh =  
    4.78844720123795  
rdh_sum =  
    4.77803793813875  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 54  
dh =  
    4.80019720123795  
rdh_sum =  
    4.94995284723646  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 55  
dh =  
    4.81194720123795  
rdh_sum =  
    5.12265819175903  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 56  
dh =  
    4.82369720123795  
rdh_sum =  
    5.29615540552312
```



```
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 57  
dh =  
    4.83544720123795  
rdh_sum =  
    5.47044591887635  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 58  
dh =  
    4.84719720123795  
rdh_sum =  
    5.64553115869104  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 59  
dh =  
    4.85894720123795  
rdh_sum =  
    5.82141254835796  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 60  
dh =  
    4.87069720123795  
rdh_sum =  
    5.99809150778011  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 65  
dh =  
    4.41112220123795  
rdh_sum =  
    6.14466526135442  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 66  
dh =  
    4.35622220123795  
rdh_sum =  
    6.28779718957001  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 73  
dh =  
    3.17299720123795  
rdh_sum =  
    6.36555891436826  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 74  
dh =  
    3.24044720123795  
rdh_sum =  
    6.44656859367674  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 75  
dh =  
    3.30857220123795  
rdh_sum =  
    6.53092012465246  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 76  
dh =  
    3.37737220123795  
rdh_sum =  
    6.61870873893987  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 77  
dh =  
    3.38909720123795  
rdh_sum =  
    6.70708929511508  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 78  
dh =  
    3.34374720123795  
rdh_sum =  
    6.79319031767134  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 87  
dh =  
    2.76949720123795  
rdh_sum =  
    6.85281072388137  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 88  
dh =  
    2.91034720123795  
rdh_sum =  
    6.91850991561035  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 89  
dh =  
    2.95689720123795  
rdh_sum =  
    6.98627840311864
```

```
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 90  
dh =  
    2.90914720123795  
rdh_sum =  
    7.05192464523216  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 91  
dh =  
    2.85632220123795  
rdh_sum =  
    7.11525970187625  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 92  
dh =  
    2.79842220123795  
rdh_sum =  
    7.17610595427901  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 93  
dh =  
    2.74052220123795  
rdh_sum =  
    7.23451011664972  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 94  
dh =  
    2.68262220123795  
rdh_sum =  
    7.29051916297073  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 95  
dh =  
    2.62472220123795  
rdh_sum =  
    7.34418032200063  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 96  
dh =  
    2.56682220123795  
rdh_sum =  
    7.39554107225041  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 97  
dh =  
    2.50894720123795  
rdh_sum =  
    7.44465009926203  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 98  
dh =  
    2.45109720123795  
rdh_sum =  
    7.49155626594893  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 103  
dh =  
    2.10582220123795  
rdh_sum =  
    7.52632301791203  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 104  
dh =  
    2.11492220123795  
rdh_sum =  
    7.56138732811712  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 105  
dh =  
    2.13012220123795  
rdh_sum =  
    7.59695138282257  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 106  
dh =  
    2.15142220123795  
rdh_sum =  
    7.63322146514012  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 107  
dh =  
    2.17274720123795  
rdh_sum =  
    7.67020509128851  
ans =  
Berm Factor Calculation: Iteration 3, Profile Segment: 108  
dh =  
    2.19409720123795  
rdh_sum =  
    7.70790979070597
```

```

ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 109
dh =
    2.21544720123795
rdh_sum =
    7.74634224981549
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 110
dh =
    2.23679720123795
rdh_sum =
    7.78550914451404
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 111
dh =
    2.26077220123795
rdh_sum =
    7.82550871864173
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 112
dh =
    2.28737220123795
rdh_sum =
    7.86644195885277
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 113
dh =
    2.34167220123795
rdh_sum =
    7.90931311293609
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 114
dh =
    2.42367220123795
rdh_sum =
    7.95519176489019
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 129
dh =
    1.09154720123795
rdh_sum =
    7.96461359987917
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 130
dh =
    1.06909720123795
rdh_sum =
    7.97365302009818
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    62
rB =
    0.295225484945149
rdh_mean =
    0.128607306775777
gamma_berm =
    0.74274266956522
slope =
    0.181646885544773
Irb =
    1.45769137051897
gamma_berm =
    0.74274266956522
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.594194135652176
ans =
!!! - - Iribaren number: 1.08 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    13.5190805274369
R2del =
    0.0975956976967538
Z2 =
    22.5046527286749
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
    -4.28312
toe_sta =
    -12.6070531009323
top_sta =
    196.545438601798

```

```
Z2 =
22.5046527286749
H0 =
8.8182
Tp =
11.5883
T0 =
10.5348181818182
R2 =
13.5190805274369
Z2 =
22.5046527286749
top_sta =
196.545438601798
Lslope =
209.152491702731
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 17
dh =
6.29127220123795
rdh_sum =
0.282460702628984
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 18
dh =
6.22707220123795
rdh_sum =
0.559787292980458
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 19
dh =
6.16412220123795
rdh_sum =
0.832108006534625
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 20
dh =
6.10242220123795
rdh_sum =
1.09955002195992
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 21
dh =
6.09154720123795
rdh_sum =
1.36613503247288
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 22
dh =
6.13149720123795
rdh_sum =
1.63587258153965
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 23
dh =
6.25207220123795
rdh_sum =
1.91519501158891
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 24
dh =
6.45327220123795
rdh_sum =
2.21073589632493
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 31
dh =
5.76017220123795
rdh_sum =
2.4516418958307
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 32
dh =
5.80497220123795
rdh_sum =
2.69596873894072
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 33
dh =
5.84559720123795
rdh_sum =
2.94341171339809
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 34
dh =
5.88204720123795
rdh_sum =
3.19366183842669
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 45
```

```
dh =
    4.93314720123795
rdh_sum =
    3.37460348110133
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 46
dh =
    4.87929720123795
rdh_sum =
    3.55186709163431
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 47
dh =
    4.86907220123795
rdh_sum =
    3.72843566437936
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 48
dh =
    4.90247220123795
rdh_sum =
    3.90727854035513
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 49
dh =
    4.89889720123795
rdh_sum =
    4.08587743947292
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 50
dh =
    4.85834720123795
rdh_sum =
    4.26171814024804
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 51
dh =
    4.82419720123795
rdh_sum =
    4.43524908232813
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 52
dh =
    4.79644720123795
rdh_sum =
    4.60691202718651
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 53
dh =
    4.78844720123795
rdh_sum =
    4.77803793813875
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 54
dh =
    4.80019720123795
rdh_sum =
    4.94995284723646
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 55
dh =
    4.81194720123795
rdh_sum =
    5.12265819175903
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 56
dh =
    4.82369720123795
rdh_sum =
    5.29615540552312
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 57
dh =
    4.83544720123795
rdh_sum =
    5.47044591887635
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 58
dh =
    4.84719720123795
rdh_sum =
    5.64553115869104
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 59
dh =
    4.85894720123795
rdh_sum =
    5.82141254835796
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 60
```

```
dh =
    4.87069720123795
rdh_sum =
    5.99809150778011
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 65
dh =
    4.41112220123795
rdh_sum =
    6.14466526135442
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 66
dh =
    4.35622220123795
rdh_sum =
    6.28779718957001
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 73
dh =
    3.17299720123795
rdh_sum =
    6.36555891436826
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 74
dh =
    3.24044720123795
rdh_sum =
    6.44656859367674
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 75
dh =
    3.30857220123795
rdh_sum =
    6.53092012465246
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 76
dh =
    3.37737220123795
rdh_sum =
    6.61870873893987
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 77
dh =
    3.38909720123795
rdh_sum =
    6.70708929511508
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 78
dh =
    3.34374720123795
rdh_sum =
    6.79319031767134
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 87
dh =
    2.76949720123795
rdh_sum =
    6.85281072388137
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 88
dh =
    2.91034720123795
rdh_sum =
    6.91850991561035
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 89
dh =
    2.95689720123795
rdh_sum =
    6.98627840311864
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 90
dh =
    2.90914720123795
rdh_sum =
    7.05192464523216
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 91
dh =
    2.85632220123795
rdh_sum =
    7.11525970187625
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 92
dh =
    2.79842220123795
rdh_sum =
    7.17610595427901
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 93
```

```
dh =
    2.74052220123795
rdh_sum =
    7.23451011664972
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 94
dh =
    2.68262220123795
rdh_sum =
    7.29051916297073
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 95
dh =
    2.62472220123795
rdh_sum =
    7.34418032200063
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 96
dh =
    2.56682220123795
rdh_sum =
    7.39554107225041
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 97
dh =
    2.50894720123795
rdh_sum =
    7.44465009926203
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 98
dh =
    2.45109720123795
rdh_sum =
    7.49155626594893
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 103
dh =
    2.10582220123795
rdh_sum =
    7.52632301791203
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 104
dh =
    2.11492220123795
rdh_sum =
    7.56138732811712
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 105
dh =
    2.13012220123795
rdh_sum =
    7.59695138282257
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 106
dh =
    2.15142220123795
rdh_sum =
    7.63322146514012
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 107
dh =
    2.17274720123795
rdh_sum =
    7.67020509128851
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 108
dh =
    2.19409720123795
rdh_sum =
    7.70790979070597
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 109
dh =
    2.21544720123795
rdh_sum =
    7.74634224981549
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 110
dh =
    2.23679720123795
rdh_sum =
    7.78550914451404
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 111
dh =
    2.26077220123795
rdh_sum =
    7.82550871864173
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 112
```

```

dh =
    2.28737220123795
rdh_sum =
    7.86644195885277
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 113
dh =
    2.34167220123795
rdh_sum =
    7.90931311293609
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 114
dh =
    2.42367220123795
rdh_sum =
    7.95519176489019
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 129
dh =
    1.09154720123795
rdh_sum =
    7.96461359987917
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 130
dh =
    1.06909720123795
rdh_sum =
    7.97365302009818
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    62
rB =
    0.296434431620929
rdh_mean =
    0.128607306775777
gamma_berm =
    0.741689202265447
slope =
    0.182040904769659
Irb =
    1.46085332081728
gamma_berm =
    0.741689202265447
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.593351361812358
ans =
!!! - - Iribaren number: 1.08 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    13.5291890836249
R2del =
    0.0101085561879799
Z2 =
    22.5147612848629
ans =
!----- STARTING ITERATION 5 -----!
Ztoe =
    -4.28312
toe_sta =
    -12.6070531009323
top_sta =
    196.634149055401
Z2 =
    22.5147612848629
H0 =
    8.8182
Tp =
    11.5883
T0 =
    10.5348181818182
R2 =
    13.5291890836249
Z2 =
    22.5147612848629
top_sta =
    196.634149055401
Lslope =
    209.241202156333
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 17
dh =
    6.29127220123795

```



```
rdh_sum =
    0.282460702628984
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 18
dh =
    6.22707220123795
rdh_sum =
    0.559787292980458
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 19
dh =
    6.16412220123795
rdh_sum =
    0.832108006534625
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 20
dh =
    6.10242220123795
rdh_sum =
    1.09955002195992
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 21
dh =
    6.09154720123795
rdh_sum =
    1.36613503247288
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 22
dh =
    6.13149720123795
rdh_sum =
    1.63587258153965
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 23
dh =
    6.25207220123795
rdh_sum =
    1.91519501158891
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 24
dh =
    6.45327220123795
rdh_sum =
    2.21073589632493
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 31
dh =
    5.76017220123795
rdh_sum =
    2.4516418958307
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 32
dh =
    5.80497220123795
rdh_sum =
    2.69596873894072
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 33
dh =
    5.84559720123795
rdh_sum =
    2.94341171339809
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 34
dh =
    5.88204720123795
rdh_sum =
    3.19366183842669
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 45
dh =
    4.93314720123795
rdh_sum =
    3.37460348110133
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 46
dh =
    4.87929720123795
rdh_sum =
    3.55186709163431
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 47
dh =
    4.86907220123795
rdh_sum =
    3.72843566437936
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 48
dh =
    4.90247220123795
```

```
rdh_sum =
    3.90727854035513
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 49
dh =
    4.89889720123795
rdh_sum =
    4.08587743947292
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 50
dh =
    4.85834720123795
rdh_sum =
    4.26171814024804
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 51
dh =
    4.82419720123795
rdh_sum =
    4.43524908232813
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 52
dh =
    4.79644720123795
rdh_sum =
    4.60691202718651
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 53
dh =
    4.78844720123795
rdh_sum =
    4.77803793813875
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 54
dh =
    4.80019720123795
rdh_sum =
    4.94995284723646
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 55
dh =
    4.81194720123795
rdh_sum =
    5.12265819175903
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 56
dh =
    4.82369720123795
rdh_sum =
    5.29615540552312
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 57
dh =
    4.83544720123795
rdh_sum =
    5.47044591887635
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 58
dh =
    4.84719720123795
rdh_sum =
    5.64553115869104
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 59
dh =
    4.85894720123795
rdh_sum =
    5.82141254835796
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 60
dh =
    4.87069720123795
rdh_sum =
    5.99809150778011
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 65
dh =
    4.41112220123795
rdh_sum =
    6.14466526135442
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 66
dh =
    4.35622220123795
rdh_sum =
    6.28779718957001
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 73
dh =
    3.17299720123795
```

```
rdh_sum =
    6.36555891436826
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 74
dh =
    3.24044720123795
rdh_sum =
    6.44656859367674
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 75
dh =
    3.30857220123795
rdh_sum =
    6.53092012465246
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 76
dh =
    3.37737220123795
rdh_sum =
    6.61870873893987
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 77
dh =
    3.38909720123795
rdh_sum =
    6.70708929511508
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 78
dh =
    3.34374720123795
rdh_sum =
    6.79319031767134
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 87
dh =
    2.76949720123795
rdh_sum =
    6.85281072388137
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 88
dh =
    2.91034720123795
rdh_sum =
    6.91850991561035
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 89
dh =
    2.95689720123795
rdh_sum =
    6.98627840311864
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 90
dh =
    2.90914720123795
rdh_sum =
    7.05192464523216
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 91
dh =
    2.85632220123795
rdh_sum =
    7.11525970187625
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 92
dh =
    2.79842220123795
rdh_sum =
    7.17610595427901
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 93
dh =
    2.74052220123795
rdh_sum =
    7.23451011664972
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 94
dh =
    2.68262220123795
rdh_sum =
    7.29051916297073
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 95
dh =
    2.62472220123795
rdh_sum =
    7.34418032200063
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 96
dh =
    2.56682220123795
```

```
rdh_sum =
    7.39554107225041
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 97
dh =
    2.50894720123795
rdh_sum =
    7.44465009926203
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 98
dh =
    2.45109720123795
rdh_sum =
    7.49155626594893
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 103
dh =
    2.10582220123795
rdh_sum =
    7.52632301791203
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 104
dh =
    2.11492220123795
rdh_sum =
    7.56138732811712
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 105
dh =
    2.13012220123795
rdh_sum =
    7.59695138282257
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 106
dh =
    2.15142220123795
rdh_sum =
    7.63322146514012
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 107
dh =
    2.17274720123795
rdh_sum =
    7.67020509128851
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 108
dh =
    2.19409720123795
rdh_sum =
    7.70790979070597
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 109
dh =
    2.21544720123795
rdh_sum =
    7.74634224981549
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 110
dh =
    2.23679720123795
rdh_sum =
    7.78550914451404
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 111
dh =
    2.26077220123795
rdh_sum =
    7.82550871864173
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 112
dh =
    2.28737220123795
rdh_sum =
    7.86644195885277
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 113
dh =
    2.34167220123795
rdh_sum =
    7.90931311293609
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 114
dh =
    2.42367220123795
rdh_sum =
    7.95519176489019
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 129
dh =
    1.09154720123795
```

```

rdh_sum =
    7.96461359987917
ans =
Berm Factor Calculation: Iteration 5, Profile Segment: 130
dh =
    1.06909720123795
rdh_sum =
    7.97365302009818
ans =
!----- End Berm Factor Calculation, Iter: 5 -----!
berm_width =
    62
rB =
    0.296308754495098
rdh_mean =
    0.128607306775777
gamma_berm =
    0.741798716394602
slope =
    0.181999881095852
Irb =
    1.4605241114553
gamma_berm =
    0.741798716394602
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.593438973115681
ans =
!!! - - Iribaren number: 1.08 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:5.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    13.5281374271026
R2del =
    0.00105165652229644
Z2 =
    22.5137096283406
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
    22.5137096283406
diary off
-1.000000e+00
-1.000000e+00

```