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diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-133
% 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-133sta_ele_include.csv'; % file with station, elevation, include
                                         % third column is 0 for excluded points
imgname='logfiles/CM-133-runup';
SWEL=8.8742; % 100-yr still water level including wave setup.
H0=5.3885; % significant wave height at toe of structure
Tp=7.957; % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.97614; % this may get changed automatically below
gamma_rough=1;
gamma_beta=1;
gamma_perm=1;

setupAtToe=-0.011821;
maxSetup=0.63595; % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-133'

plotTitle =

Iterative TAW for CM-133

% END CONFIG
%-----

SWEL=SWEL+setupAtToe

SWEL =

8.862379

SWEL_fore=SWEL+maxSetup

SWEL_fore =

9.498329

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

L0 =

267.740737115654

% 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 =

    0.7796290000000002

% 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 =

    16.945129

% 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 =

    7.25831657355681

top_sta =

    72.5770132030357

% check to make sure we got them, if not extend the end slopes outward
S=diff(dep)./diff(sta);
if toe_sta== -999
    dy=dep(1)-Ztoe;
    toe_sta=sta(1)-dy/S(1)
end
if top_sta== -999
    dy=Z2-dep(end);
    top_sta=sta(end)+dy/S(end)
end

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

top_sta =

    72.5770132030357

toe_sta

toe_sta =

    7.25831657355681

% 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 106.9 ft landward of toe of slope

ans =

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

ans =

-!!!-      setup is adjusted to 0.30 feet

ans =

-!!!-      SWEL is adjusted to 9.17 feet

k =

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% now iterate converge on a runup elevation
tol=0.01; % convergence criteria
R2del=999;
R2_new=3*H0; %initial guess
R2=R2_new;
iter=0;
R2_all=[];
topStaAll=[];
Berm_Segs=[];
TAW_ALWAYS_VALID=1;
while(abs(R2del) > tol && iter <= 25)
    iter=iter+1;
    sprintf('!----- STARTING ITERATION %d -----!',iter)
    % elevation of toe of slope
    Ztoe
    % station of toe slope (relative to 0-NAVD88 shoreline)
    toe_sta
    % station of top of slope/extent of 2% run-up
    top_sta
    % elevation of top of slope/extent of 2% run-up
    Z2
    % incident significant wave height
    H0
    % incident spectral peak wave period
    Tp
    % incident spectral mean wave period
    T0

    R2=R2_new
    Z2=R2+SWEL
    % determine slope for this iteration
    top_sta=-999;
    for kk=1:length(sta)-1
        if ((Z2 > dep(kk)) & (Z2 <= dep(kk+1))) % here is the intersection of z2 with profile
            top_sta=interp1(dep(kk:kk+1),sta(kk:kk+1),Z2)
            break;
        end
    end
    if top_sta==-999
        dy=Z2-dep(end);
        top_sta=sta(end)+dy/S(end)
    end

    % get the length of the slope (not accounting for berm)
    Lslope=top_sta-toe_sta

    % loop over profile segments to determine berm factor
    % re-calculate influence of depth of berm based on this run-up elevation
    % check for berm, berm width, berm height
    berm_width=0;
    rdh_sum=0;
    Berm_Segs=[];
    Berm_Heights=[];
    for kk=1:length(sta)-1
        ddep=dep(kk+1)-dep(kk);
        dsta=sta(kk+1)-sta(kk);
        s=ddep/dsta;
        if (s < 1/15) % count it as a berm if slope is flatter than 1:15 (see TAW manual)
            sprintf('Berm Factor Calculation: Iteration %d, Profile Segment: %d',iter,kk)
            berm_width=berm_width+dsta; % tally the width of all berm segments
            % compute the rdh for this segment and weight it by the segment length
            dh=SWEL-(dep(kk)+dep(kk+1))/2
            if dh < 0
                chi=R2;
            else
                chi=2* H0;
            end
            if (dh <= R2 & dh >=-2*H0)
                rdh=(0.5-0.5*cos(3.14159*dh/chi)) ;
            else
                rdh=1;
            end
            rdh_sum=rdh_sum + rdh * dsta
            Berm_Segs=[Berm_Segs, kk];
            Berm_Heights=[Berm_Heights, (dep(kk)+dep(kk+1))/2];
        end
        if dep(kk) >= Z2 % jump out of loop if we reached limit of run-up for this iteration
            break
        end
    end
    sprintf('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
    berm_width
    rB=berm_width/Lslope
    if (berm_width > 0)
        rdh_mean=rdh_sum/berm_width
    else

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        rdh_mean=1
    end
    gamma_berm=1- rB * (1-rdh_mean)
    if gamma_berm > 1
        gamma_berm=1
    end
    if gamma_berm < 0.6
        gamma_berm =0.6
    end
    % Iribarren number
    slope=(Z2-Ztoe)/(Lslope-berm_width)
    Irb=(slope/(sqrt(H0/L0)))
    % runup height
    gamma_berm
    gamma_perm
    gamma_beta
    gamma_rough
    gamma=gamma_berm*gamma_perm*gamma_beta*gamma_rough

    % check validity
    TAW_VALID=1;
    if (Irb*gamma_berm < 0.5 | Irb*gamma_berm > 10 )
        sprintf('!!! - - Iribarren number: %6.2f is outside the valid range (0.5-10), TAW NOT VALID - - !!!\n', Irb*gamma_berm)
        TAW_VALID=0;
    else
        sprintf('!!! - - Iribarren number: %6.2f is in the valid range (0.5-10), TAW RECOMMENDED - - !!!\n', Irb*gamma_berm)
    end
    islope=1/slope;
    if (slope < 1/8 | slope > 1)
        sprintf('!!! - - slope: 1:%3.1f V:H is outside the valid range (1:8 - 1:1), TAW NOT VALID - - !!!\n', islope)
        TAW_VALID=0;
    else
        sprintf('!!! - - slope: 1:%3.1f V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!\n', islope)
    end
    if TAW_VALID == 0
        TAW_ALWAYS_VALID=0;
    end

    if (Irb*gamma_berm < 1.8)
        R2_new=gamma*H0*1.77*Irb
    else
        R2_new=gamma*H0*(4.3-(1.6/sqrt(Irb)))
    end
    % check to see if we need to evaluate a shallow foreshore
    if berm_width > 0.25 * L0;
        disp('!   Berm width is greater than 1/4 wave length')
        disp('!   Runup will be weighted average with foreshore calculation assuming depth limited wave height on berm')
        % do the foreshore calculation
        fore_H0=0.78*(SWEL_fore-min(Berm_Heights))
        % get upper slope
        fore_toe_sta=-999;
        fore_toe_dep=-999;
        for kk=length(dep)-1:-1:1
            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

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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 =
    0.779629000000002
toe_sta =
    7.25831657355681
top_sta =
    72.5770132030357
Z2 =
    16.945129
H0 =
    5.3885
Tp =
    7.957
T0 =
    7.23363636363636
R2 =
    16.1655
Z2 =
    25.3385393291962
top_sta =
    82.680816986195
Lslope =
    75.4225004126382
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 1
dh =
    8.00806432919624
rdh_sum =
    0.845772093619118
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 2
dh =
    7.94908932919624
rdh_sum =
    1.68528431013154
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 3
dh =
    7.89018932919624
rdh_sum =
    2.51844445866523
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 36
dh =
    4.00816432919624
rdh_sum =
    2.82263918920194
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 37
dh =
    3.99901432919624
rdh_sum =
    3.12560748251423
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    5
rB =
    0.0662932145267644
rdh_mean =
    0.625121496502846
gamma_berm =
    0.975148098946191
slope =
    0.348736698999527
Irb =
    2.45822106627126
gamma_berm =
    0.975148098946191
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    1
gamma =
    0.975148098946191
ans =
!!! - - Iribaren number: 2.40 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =

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R2del = 17.2324563960187
Z2 = 1.06695639601867
26.4054957252149
ans =
!----- STARTING ITERATION 2 -----!
Ztoe = 0.779629000000002
toe_sta = 7.25831657355681
top_sta = 85.7792819085666
Z2 = 26.4054957252149
H0 = 5.3885
Tp = 7.957
T0 = 7.23363636363636
R2 = 17.2324563960187
Z2 = 26.4054957252149
top_sta = 85.7792819085666
Lslope = 78.5209653350098
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 1
dh = 8.00806432919624
rdh_sum = 0.845772093619118
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 2
dh = 7.94908932919624
rdh_sum = 1.68528431013154
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 3
dh = 7.89018932919624
rdh_sum = 2.51844445866523
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 36
dh = 4.00816432919624
rdh_sum = 2.82263918920194
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 37
dh = 3.99901432919624
rdh_sum = 3.12560748251423
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width = 5
rB = 0.063677260954033
rdh_mean = 0.625121496502846
gamma_berm = 0.976128763706754
slope = 0.348551826114451
Irb = 2.45691790998751
gamma_berm = 0.976128763706754
gamma_perm = 1
gamma_beta = 1
gamma_rough = 1
gamma = 0.976128763706754
ans =
!!! - - Iribaren number: 2.40 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new = 17.2483630200161
R2del =

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0.0159066239974024
Z2 =
26.4214023492123
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
0.779629000000002
toe_sta =
7.25831657355681
top_sta =
85.8254750957233
Z2 =
26.4214023492123
H0 =
5.3885
Tp =
7.957
T0 =
7.23363636363636
R2 =
17.2483630200161
Z2 =
26.4214023492123
top_sta =
85.8254750957233
Lslope =
78.5671585221665
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 1
dh =
8.00806432919624
rdh_sum =
0.845772093619118
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 2
dh =
7.94908932919624
rdh_sum =
1.68528431013154
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 3
dh =
7.89018932919624
rdh_sum =
2.51844445866523
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 36
dh =
4.00816432919624
rdh_sum =
2.82263918920194
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 37
dh =
3.99901432919624
rdh_sum =
3.12560748251423
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
5
rB =
0.0636398222113293
rdh_mean =
0.625121496502846
gamma_berm =
0.976142798686592
slope =
0.348549187766797
Irb =
2.4568993124559
gamma_berm =
0.976142798686592
gamma_perm =
1
gamma_beta =
1
gamma_rough =
1
gamma =
0.976142798686592
ans =
!!! - - Iribaren number: 2.40 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:2.9 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
17.2485906996177
R2del =
0.000227679601586317
Z2 =

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                26.4216300288139
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
                26.4216300288139
diary off
-1.000000e+00
-1.000000e+00
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