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diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-141
% 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-141sta_ele_include.csv'; % file with station, elevation, include
% third column is 0 for excluded points
imgname='logfiles/CM-141-runup';
SWEL=8.7636; % 100-yr still water level including wave setup.
H0=6.4243; % significant wave height at toe of structure
Tp=15.2662; % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.95946; % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=1.1599;
maxSetup=1.8064; % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-141'

plotTitle =

Iterative TAW for CM-141

% END CONFIG
%-----

SWEL=SWEL+setupAtToe

SWEL =

          9.9235

SWEL_fore=SWEL+maxSetup

SWEL_fore =

          11.7299

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

L0 =

          985.547666507327

% 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 =

    0.2870500000000001

% 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 =

    19.55995

% 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 =

    2.44308782985428

top_sta =

    92.2007446166231

% 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 =

    92.2007446166231

toe_sta

toe_sta =

    2.44308782985428

% 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 118.7 ft landward of toe of slope

ans =

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

ans =

-!!-      setup is adjusted to 1.41 feet

ans =

-!!-      SWEL is adjusted to 10.18 feet

k =

    1
    2
    3
    4
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% now iterate converge on a runup elevation
tol=0.01; % convergence criteria

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

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

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

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

    sprintf('!----- End Berm Factor Calculation, Iter: %d -----!',iter)
    berm_width
    rB=berm_width/Lslope
    if (berm_width > 0)
        rdh_mean=rdh_sum/berm_width
    else
        rdh_mean=1
    end
    gamma_berm=1- rB * (1-rdh_mean)
    if gamma_berm > 1
        gamma_berm=1
    end
end

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

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    end
    topStaAll(iter)=top_sta;
end
ans =
!----- STARTING ITERATION 1 -----!
Ztoe =
    0.287050000000001
toe_sta =
    2.44308782985428
top_sta =
    92.2007446166231
Z2 =
    19.55995
H0 =
    6.4243
Tp =
    15.2662
T0 =
    13.8783636363636
R2 =
    19.2729
Z2 =
    29.4493163889274
top_sta =
    108.947421364434
Lslope =
    106.504333534579
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 2
dh =
    9.51829138892739
rdh_sum =
    0.843192118054353
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 3
dh =
    9.46924138892739
rdh_sum =
    1.68199872128155
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 4
dh =
    9.43559138892739
rdh_sum =
    2.51776848739584
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 5
dh =
    9.41734138892739
rdh_sum =
    3.35188171208324
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 44
dh =
    2.87424138892739
rdh_sum =
    3.47035627227395
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 45
dh =
    2.86029138892739
rdh_sum =
    3.58773075885453
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 46
dh =
    2.83801638892739
rdh_sum =
    3.70335791059276
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 47
dh =
    2.80741638892739
rdh_sum =
    3.81660328368559
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    8
rB =
    0.0751143144555954
rdh_mean =
    0.477075410460699
gamma_berm =
    0.960720877944782
slope =
    0.296050593334457
Irb =
    3.66683903686968
gamma_berm =

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0.960720877944782
gamma_perm =
1
gamma_beta =
1
gamma_rough =
0.8
gamma =
0.768576702355825
ans =
!!! - - Iribaren number: 3.52 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.4 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
17.1059397119876
R2del =
2.16696028801244
Z2 =
27.2823561009149
top_sta =
105.832326389285
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
0.287050000000001
toe_sta =
2.44308782985428
top_sta =
105.832326389285
Z2 =
27.2823561009149
H0 =
6.4243
Tp =
15.2662
T0 =
13.8783636363636
R2 =
17.1059397119876
Z2 =
27.2823561009149
top_sta =
105.832326389285
Lslope =
103.389238559431
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 2
dh =
9.51829138892739
rdh_sum =
0.843192118054353
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 3
dh =
9.46924138892739
rdh_sum =
1.68199872128155
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 4
dh =
9.43559138892739
rdh_sum =
2.51776848739584
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 5
dh =
9.41734138892739
rdh_sum =
3.35188171208324
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 44
dh =
2.87424138892739
rdh_sum =
3.47035627227395
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 45
dh =
2.86029138892739
rdh_sum =
3.58773075885453
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 46
dh =
2.83801638892739
rdh_sum =
3.70335791059276
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 47
dh =

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rdh_sum = 2.80741638892739
ans = 3.81660328368559
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width = 8
rB = 0.0773774921981015
rdh_mean = 0.477075410460699
gamma_berm = 0.959537406652727
slope = 0.283001589158257
Irb = 3.5052159934343
gamma_berm = 0.959537406652727
gamma_perm = 1
gamma_beta = 1
gamma_rough = 0.8
gamma = 0.767629925322182
ans =
!!! - - Iribaren number: 3.36 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new = 16.9909410682915
R2del = 0.114998643696016
Z2 = 27.1673574572189
top_sta = 105.625754368994
ans =
!----- STARTING ITERATION 3 -----!
Ztoe = 0.287050000000001
toe_sta = 2.44308782985428
top_sta = 105.625754368994
Z2 = 27.1673574572189
H0 = 6.4243
Tp = 15.2662
T0 = 13.8783636363636
R2 = 16.9909410682915
Z2 = 27.1673574572189
top_sta = 105.625754368994
Lslope = 103.18266653914
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 2
dh = 9.51829138892739
rdh_sum = 0.843192118054353
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 3
dh = 9.46924138892739
rdh_sum = 1.68199872128155
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 4
dh = 9.43559138892739
rdh_sum = 2.51776848739584
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 5
dh = 9.41734138892739
rdh_sum = 3.35188171208324
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 44
dh =

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      2.87424138892739
rdh_sum =
      3.47035627227395
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 45
dh =
      2.86029138892739
rdh_sum =
      3.58773075885453
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 46
dh =
      2.83801638892739
rdh_sum =
      3.70335791059276
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 47
dh =
      2.80741638892739
rdh_sum =
      3.81660328368559
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
      8
rB =
      0.0775324021788621
rdh_mean =
      0.477075410460699
gamma_berm =
      0.959456400414622
slope =
      0.282407589896272
Irb =
      3.49785880607931
gamma_berm =
      0.959456400414622
gamma_perm =
      1
gamma_beta =
      1
gamma_rough =
      0.8
gamma =
      0.767565120331698
ans =
!!! - - Iribaren number: 3.36 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.5 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
      16.9850771531085
R2del =
      0.00586391518305973
Z2 =
      27.1614935420359
top_sta =
      105.615221020363
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
      27.1614935420359
diary off
-1.000000e+00

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