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diary on          % begin recording

% FEMA appeal for The Town of Harpswell, Cumberland county, Maine
% TRANSECT ID: CM-145
% 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-145sta_ele_include.csv'; % file with station, elevation, include
                                         % third column is 0 for excluded points
imgname='logfiles/CM-145-runup';
SWEL=8.8099; % 100-yr still water level including wave setup.
H0=8.5251; % significant wave height at toe of structure
Tp=11.4911; % peak period, 1/fma,
T0=Tp/1.1;

gamma_berm=0.95254; % this may get changed automatically below
gamma_rough=0.8;
gamma_beta=1;
gamma_perm=1;

setupAtToe=-0.03793;
maxSetup=1.1002; % only used in case of berm/shallow foreshore weighted average

plotTitle='Iterative TAW for CM-145'

plotTitle =

Iterative TAW for CM-145

% END CONFIG
%-----

SWEL=SWEL+setupAtToe

SWEL =

8.77197

SWEL_fore=SWEL+maxSetup

SWEL_fore =

9.87217

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

L0 =

558.391690298303

% 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 =

        -4.01568

% 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 =

        21.55962

% 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 =

        -23.9617354939885

top_sta =

        68.6101870716799

% 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 =

        68.6101870716799

toe_sta

toe_sta =

        -23.9617354939885

% 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 65.1 ft landward of toe of slope

ans =

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

ans =

-!!!-      setup is adjusted to 0.14 feet

ans =

-!!!-      SWEL is adjusted to 8.95 feet

k =

    1
    2
    3
    4
    5
    6
    7
    8
    9
   10
   11

% 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
end
if top_sta== -999
    dy=Z2-dep(end);

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        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
    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
end

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% 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 =
    -4.01568
toe_sta =
    -23.9617354939885
top_sta =
    68.6101870716799
Z2 =
    21.55962
H0 =
    8.5251
Tp =
    11.4911
T0 =
    10.4464545454545
R2 =
    25.5753
Z2 =
    34.5228664642314
top_sta =
    126.983337402331
Lslope =
    150.94507289632
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 6
dh =
    12.0584414642314
rdh_sum =
    0.803005262087444
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 7
dh =
    12.0481914642314

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rdh_sum =
    1.60525882777874
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 42
dh =
    2.13091646423142
rdh_sum =
    1.64330635863373
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 43
dh =
    2.07781646423143
rdh_sum =
    1.67950425045875
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 44
dh =
    2.02601646423143
rdh_sum =
    1.71394056532371
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 45
dh =
    1.97551646423143
rdh_sum =
    1.74670033892783
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 86
dh =
    -11.9684835357686
rdh_sum =
    2.19647261320465
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 87
dh =
    -11.9929835357686
rdh_sum =
    2.64774225273241
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 88
dh =
    -12.0282835357686
rdh_sum =
    3.10117009312888
ans =
Berm Factor Calculation: Iteration 1, Profile Segment: 89
dh =
    -12.0743835357686
rdh_sum =
    3.5574177460719
ans =
!----- End Berm Factor Calculation, Iter: 1 -----!
berm_width =
    10
rB =
    0.0662492641072739
rdh_mean =
    0.35574177460719
gamma_berm =
    0.957318366672668
slope =
    0.273429540120077
Irb =
    2.21291720002817
gamma_berm =
    0.957318366672668
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.765854693338135
ans =
!!! - - Iribaren number: 2.12 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.7 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    21.052284975238
R2del =
    4.52301502476195
Z2 =
    29.9998514394695
ans =
!----- STARTING ITERATION 2 -----!
Ztoe =
    -4.01568
toe_sta =
    -23.9617354939885

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top_sta =
    97.8120054141856
Z2 =
    29.9998514394695
H0 =
    8.5251
Tp =
    11.4911
T0 =
    10.4464545454545
R2 =
    21.052284975238
Z2 =
    29.9998514394695
top_sta =
    97.8120054141856
Lslope =
    121.773740908174
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 6
dh =
    12.0584414642314
rdh_sum =
    0.803005262087444
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 7
dh =
    12.0481914642314
rdh_sum =
    1.60525882777874
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 42
dh =
    2.13091646423142
rdh_sum =
    1.64330635863373
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 43
dh =
    2.07781646423143
rdh_sum =
    1.67950425045875
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 44
dh =
    2.02601646423143
rdh_sum =
    1.71394056532371
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 45
dh =
    1.97551646423143
rdh_sum =
    1.74670033892783
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 86
dh =
    -11.9684835357686
rdh_sum =
    2.35348948813796
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 87
dh =
    -11.9929835357686
rdh_sum =
    2.96206378207293
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 88
dh =
    -12.0282835357686
rdh_sum =
    3.57320758355696
ans =
Berm Factor Calculation: Iteration 2, Profile Segment: 89
dh =
    -12.0743835357686
rdh_sum =
    4.18770237606831
ans =
!----- End Berm Factor Calculation, Iter: 2 -----!
berm_width =
    10
rB =
    0.0821195105399669
rdh_mean =
    0.418770237606831
gamma_berm =
    0.952269696401012
slope =
    0.304324890292563

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Irb =
    2.46295913685608
gamma_berm =
    0.952269696401012
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.761815757120809
ans =
!!! - - Iribaren number: 2.35 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    21.3053260939424
R2del =
    0.253041118704378
Z2 =
    30.2528925581738
ans =
!----- STARTING ITERATION 3 -----!
Ztoe =
    -4.01568
toe_sta =
    -23.9617354939885
top_sta =
    99.4440023100539
Z2 =
    30.2528925581738
H0 =
    8.5251
Tp =
    11.4911
T0 =
    10.4464545454545
R2 =
    21.3053260939424
Z2 =
    30.2528925581738
top_sta =
    99.4440023100539
Lslope =
    123.405737804042
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 6
dh =
    12.0584414642314
rdh_sum =
    0.803005262087444
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 7
dh =
    12.0481914642314
rdh_sum =
    1.60525882777874
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 42
dh =
    2.13091646423142
rdh_sum =
    1.64330635863373
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 43
dh =
    2.07781646423143
rdh_sum =
    1.67950425045875
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 44
dh =
    2.02601646423143
rdh_sum =
    1.71394056532371
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 45
dh =
    1.97551646423143
rdh_sum =
    1.74670033892783
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 86
dh =
    -11.9684835357686
rdh_sum =
    2.34310470848153
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 87

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dh =
    -11.9929835357686
rdh_sum =
    2.94128088302934
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 88
dh =
    -12.0282835357686
rdh_sum =
    3.54200764410173
ans =
Berm Factor Calculation: Iteration 3, Profile Segment: 89
dh =
    -12.0743835357686
rdh_sum =
    4.14606122127127
ans =
!----- End Berm Factor Calculation, Iter: 3 -----!
berm_width =
    10
rB =
    0.0810335092836537
rdh_mean =
    0.414606122127127
gamma_berm =
    0.952563479762795
slope =
    0.302176708354807
Irb =
    2.44557349243462
gamma_berm =
    0.952563479762795
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.762050783810236
ans =
!!! - - Iribaren number: 2.33 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    21.2883980394838
R2del =
    0.016928054458667
Z2 =
    30.2359645037152
ans =
!----- STARTING ITERATION 4 -----!
Ztoe =
    -4.01568
toe_sta =
    -23.9617354939885
top_sta =
    99.3348242742031
Z2 =
    30.2359645037152
H0 =
    8.5251
Tp =
    11.4911
T0 =
    10.4464545454545
R2 =
    21.2883980394838
Z2 =
    30.2359645037152
top_sta =
    99.3348242742031
Lslope =
    123.296559768192
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 6
dh =
    12.0584414642314
rdh_sum =
    0.803005262087444
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 7
dh =
    12.0481914642314
rdh_sum =
    1.60525882777874
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 42
dh =
    2.13091646423142

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rdh_sum =
    1.64330635863373
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 43
dh =
    2.07781646423143
rdh_sum =
    1.67950425045875
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 44
dh =
    2.02601646423143
rdh_sum =
    1.71394056532371
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 45
dh =
    1.97551646423143
rdh_sum =
    1.74670033892783
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 86
dh =
    -11.9684835357686
rdh_sum =
    2.34379311999204
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 87
dh =
    -11.9929835357686
rdh_sum =
    2.94265861905729
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 88
dh =
    -12.0282835357686
rdh_sum =
    3.54407600068065
ans =
Berm Factor Calculation: Iteration 4, Profile Segment: 89
dh =
    -12.0743835357686
rdh_sum =
    4.14882185617557
ans =
!----- End Berm Factor Calculation, Iter: 4 -----!
berm_width =
    10
rB =
    0.0811052637543244
rdh_mean =
    0.414882185617557
gamma_berm =
    0.952543865337158
slope =
    0.302318486755424
Irb =
    2.44672093195846
gamma_berm =
    0.952543865337158
gamma_perm =
    1
gamma_beta =
    1
gamma_rough =
    0.8
gamma =
    0.762035092269727
ans =
!!! - - Iribaren number: 2.33 is in the valid range (0.5-10), TAW RECOMMENDED - - !!!
ans =
!!! - - slope: 1:3.3 V:H is in the valid range (1:8 - 1:1), TAW RECOMMENDED - - !!!
R2_new =
    21.2895184139499
R2del =
    0.00112037446614011
Z2 =
    30.2370848781813
% final 2% runup elevation
Z2=R2_new+SWEL
Z2 =
    30.2370848781813
diary off
-1.000000e+00

```