ATTACHMENT 3
STABILITY EVALUATION REPORT

TETRA TECH

April 9, 2009

M E M O R A N D U M

From John Bosche
510 302 6295

RE: Stability Evaluation of Proposed Shoreline Rip Rap Revetment and Soil Cover Parcel B, Hunters Point

Objective

Perform a cursory evaluation of static and dynamic (earthquake) stability of the proposed rip-rap shoreline protection and soil cover at Hunters Point Parcel B.

Information Sources:

1. Soil boring logs IR07MW21A2, IR07MW20A2, IR07MW24A, IR07MW25A, IR07MW26A, IR07MWP-1, IR07MWP-2, IR07MWS-3, and IR07MWS-4. The borings locations were determined from a copy of the 2008 Land Survey, IR Sites and Restrictions Related to Radionuclides, Prepared by Kurt Cholak, Tetra Tech EM Inc. dated 12/12/08. Borings without soil samples and blowcount information were not included the review data set. Borings were dated from 1986, 1990 and 2000.

2. Draft figures dated 1/15/09 including: Figure 4, Existing Topography and Cross Sections, Figure 6, Cross Sections I, L, and O, Figure 7, Cross Sections T and V, Figure 8, Cross Section X, and Figure 9, Proposed Cover Contours.

3. Three draft drawings (all are currently labeled as Drawing No. C-5 and all are dated 4/6/09). These 3 drawings contain the following cross sections, A, B, C, D, E, F, AA, BB, DD, and EE of the proposed revetment.

4. Tetra Tech EM Inc. 2004. "Final, Parcel E Nonstandard Data Gaps Investigation, Landfill Liquefaction Potential, Hunters Point Shipyard." August 13.

5. DMG. 2000. "Seismic Hazard Evaluation of the City and County of San Francisco, California." Open File Report 2000-009. Online address: http://gmw.consrv.ca.gov/shmp/download/evalrpt/sf_eval.pdf.

Work Performed:

1. Reviewed soil boring logs

2. Prepared cross section of proposed ground surface including revetment. Where soil data were not available near the toe of slope, assumed that the subsurface material consists of weak bay mud. Assigned assumed strength parameters and conducted static and pseudo static slope stability analyses.

3. Reviewed the liquefaction study performed to the Parcel E Landfill.

4. Conducted simplified Newmark analysis by using the yield acceleration determined in Step 2 above and 0.5 g earthquake acceleration from liquefaction study (Step 3 above) to evaluate possible earthquake movements of the proposed slope.

Discussion and Results:

1. The borings were each located near the top of the existing shoreline embankment. A variety of materials were logged in the borings although most materials logged were sands and gravels. Materials above the water table, cohesive materials, cobbles and gravels were not generally considered to be susceptible to liquefaction during earthquakes. No grain size distribution or -200 information was available and soil strength tests were not available.

2. There are some layers of soil below the groundwater table that may be susceptible to soil liquefaction. SM and SP layers that may be most susceptible to liquefaction were identified in IR07MW20A2 and IR07MW21A2. As previously stated, the existing soils at the site area variable, so the SM and SP layers observed in these two borings are not continuous. However, soil data at the site was generated by a variety of investigators, primarily for environmental studies. No comprehensive investigation of geotechnical parameters or evaluation of liquefaction potential has been performed at the site. The California Division of Mines and Geology (Open File Report 200-009) has identified this area on the State of California, Seismic Hazard Zones, Official Map as one "…where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements..."

3. A proposed slope inclination of 4:1 is inherently stable under static conditions for rip rap embankments founded on sand and for most embankments founded on clays. Using an assumed soil profile and assumed soil parameters to model weak clays near the toe of the slope, a static slope stability factor of safety (FS) was calculated. The FS result exceeded 2 which indicates a stable slope under static conditions. A yield acceleration was calculated for the purpose of evaluating potential slope movements during earthquake shaking. The yield acceleration for the postulated soil profile and assumed soil strengths is 0.2g.

4. Selection of the maximum probable earthquake (MPE) and the peak ground acceleration (PGA) was based on prior work at Hunters Point for the Parcel E Landfill. The M7.9 1906 San Francisco earthquake was selected as the MPE because it was the largest

recorded historical earthquake. The 1906 earthquake occurred on the Peninsular segment of the San Andreas Fault, which is the fault closest to the site.

The design earthquake has the following characteristics:

- Location: San Andreas Fault Peninsula Segment
- Magnitude: 7.9
- Distance from site: 12 kilometers
- Estimated PGA: 0.5 g

5. Newmark analysis was performed for the postulated soil profile. A peak ground acceleration of 0.5g was used in the analysis, consistent with the Parcel E Liquefaction Study. Due to the variety of earthquake records and calculations performed, displacement estimates vary from less than 1 cm to 38 cm. Most of the estimated displacements are less than 10 cm.

Conclusions

The conclusions and recommendations of this evaluation are as follows:

1. The proposed slope of the revetment and the soil cover is expected to be stable under static loading.

2. Under earthquake shaking, permanent deformation of the ground surface may occur which might disrupt the proposed soil cover. Since no development (dwellings, office, or industrial construction) on the cover is proposed, the impact of such displacements are expected to be minor and easily repairable.

3. Soil liquefaction during earthquake shaking is also a possibility. Based on the geotechnical data reviewed, most of the soils are not expected to be highly susceptible to soil liquefaction during earthquake shaking. Because liquefaction causes extreme loss of soil strength, the areas that may be involved in possible displacements and the magnitude of displacements are difficult to predict based on the available information. However, since no development on the cover is proposed, it is likely that any damages to the cover will be able to be readily repaired.

4. Because structural improvements are not proposed on the cover surface, damages that might occur due to earthquake slope stability deformations or soil liquefaction during earthquakes are expected to be most economically repaired after the fact. This is because ground improvement techniques for subsurface materials are expensive relative to the cost of surface grading.

5. Damages from earthquakes are anticipated to be minimal; however, inspections of the site following earthquakes of magnitude 6.0 should be conducted to assess and repair any damages. The magnitude which triggers an inspection should be assessed following seismic events and any changes in land use.

6. More accurate evaluation of site impacts during earthquakes would require subsurface investigation, testing, and more thorough evaluation/study. Considering the ease of surface repairs to the cover and the potential cost of site improvements prior to earthquake shaking, such effort is not recommended at this time.

If you have any questions regarding this memo, please contact me at (510) 302-6295.

Sincerely,
TETRA TECH EM INC.

John Bosche
California Civil (#30241)
California Geotechnical Engineer (#156)

Attachments: Attachment 1, Static Stability Analysis Results
Attachment 2, Dynamic Stability Analysis Results
Attachment 3, Newmark Analysis Results by 3 Methods

ATTACHMENT 1

STATIC STABILITY ANALYSIS RESULTS

(12 pages)

** PCSTABL6 **

by
Purdue University

modified by
Peter J. Bosscher
University of Wisconsin-Madison

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

PROBLEM DESCRIPTION   Static with Assumed Parameters

BOUNDARY COORDINATES

8 Top   Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	50.00	28.00	50.00	1
2	28.00	50.00	78.00	51.00	1
3	78.00	51.00	154.00	54.90	1
4	154.00	54.90	158.00	55.00	2
5	158.00	55.00	218.00	70.00	2
6	218.00	70.00	223.00	70.00	2
7	223.00	70.00	258.00	70.00	3
8	258.00	70.00	348.00	72.00	3
9	153.00	54.90	159.00	52.00	1
10	159.00	52.00	183.00	58.00	1
11	183.00	58.00	219.00	67.00	3
12	219.00	67.00	223.00	70.00	3
13	0.00	29.00	171.00	29.00	3
14	171.00	29.00	183.00	58.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion Intercept	Friction Angle	Pore Pressure	Pressure Constant	Piez. Surface

No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	115.0	115.0	400.0	0.0	0.00	0.0	0
2	135.0	135.0	0.0	40.0	0.00	0.0	0
3	120.0	120.0	0.0	30.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	50.00
2	28.00	50.00
3	78.00	51.00
4	153.00	54.90
5	230.00	55.50
6	348.00	60.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 80.00 ft.
and X = 158.00 ft.

Each Surface Terminates Between X = 180.00 ft.
and X = 340.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 10.00 ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation. The Angle Has Been Restricted Between The Angles Of -90.0 And 5.0 deg.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	104.63	52.37
2	107.94	50.12
3	111.37	48.05
4	114.89	46.16
5	118.51	44.45
6	122.20	42.93
7	125.98	41.59
8	129.81	40.46
9	133.70	39.51
10	137.63	38.77
11	141.59	38.23
12	145.58	37.90
13	149.58	37.77
14	153.58	37.84
15	157.57	38.12
16	161.54	38.60
17	165.48	39.28
18	169.38	40.16
19	173.23	41.24
20	177.02	42.52
21	180.74	43.99
22	184.38	45.65
23	187.93	47.49
24	191.39	49.51
25	194.73	51.70
26	197.96	54.06
27	201.06	56.59
28	204.03	59.26
29	206.86	62.09
30	209.55	65.06
31	212.07	68.16
32	212.39	68.60

Circle Center At X = 150.2 ; Y = 116.0 and Radius, 78.3

*** 2.737 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	104.63	52.37
2	108.22	50.59
3	111.87	48.95
4	115.58	47.46
5	119.34	46.11
6	123.16	44.91

7	127.02	43.86
8	130.92	42.96
9	134.84	42.21
10	138.80	41.62
11	142.78	41.18
12	146.77	40.90
13	150.76	40.77
14	154.76	40.80
15	158.76	40.98
16	162.75	41.32
17	166.72	41.82
18	170.66	42.46
19	174.58	43.27
20	178.47	44.22
21	182.31	45.32
22	186.11	46.58
23	189.86	47.98
24	193.55	49.52
25	197.17	51.21
26	200.73	53.04
27	204.21	55.00
28	207.62	57.10
29	210.94	59.33
30	214.17	61.69
31	217.31	64.17
32	220.35	66.77
33	223.28	69.49
34	223.79	70.00

Circle Center At X = 152.0 ; Y = 143.5 and Radius, 102.7

*** 2.740 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	121.05	53.21
2	124.43	51.06
3	127.90	49.08
4	131.48	47.29
5	135.14	45.67
6	138.88	44.25
7	142.68	43.01
8	146.54	41.98
9	150.45	41.13
10	154.40	40.49
11	158.38	40.05
12	162.37	39.82
13	166.37	39.78
14	170.37	39.95
15	174.35	40.32
16	178.31	40.89
17	182.23	41.67
18	186.11	42.64
19	189.94	43.81
20	193.70	45.17
21	197.39	46.72

22	200.99	48.45
23	204.50	50.37
24	207.91	52.46
25	211.21	54.72
26	214.39	57.15
27	217.44	59.73
28	220.36	62.47
29	223.14	65.35
30	225.76	68.37
31	227.04	70.00

Circle Center At X = 165.0 ; Y = 118.5 and Radius, 78.7

*** 2.758 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	121.05	53.21
2	124.16	50.69
3	127.41	48.36
4	130.79	46.23
5	134.30	44.31
6	137.92	42.61
7	141.64	41.13
8	145.44	39.88
9	149.31	38.86
10	153.23	38.08
11	157.19	37.53
12	161.18	37.23
13	165.18	37.18
14	169.18	37.36
15	173.16	37.79
16	177.10	38.46
17	180.99	39.36
18	184.83	40.50
19	188.59	41.88
20	192.25	43.47
21	195.82	45.29
22	199.26	47.32
23	202.58	49.56
24	205.76	51.99
25	208.78	54.61
26	211.63	57.41
27	214.32	60.38
28	216.81	63.50
29	219.12	66.77
30	221.10	70.00

Circle Center At X = 164.1 ; Y = 103.0 and Radius, 65.9

*** 2.774 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	125.16	53.42
2	128.22	50.85
3	131.45	48.49
4	134.84	46.36
5	138.36	44.47
6	142.01	42.83
7	145.76	41.44
8	149.60	40.31
9	153.51	39.45
10	157.46	38.86
11	161.45	38.54
12	165.45	38.50
13	169.44	38.74
14	173.41	39.25
15	177.33	40.03
16	181.19	41.08
17	184.97	42.39
18	188.65	43.96
19	192.21	45.78
20	195.64	47.84
21	198.92	50.13
22	202.04	52.64
23	204.97	55.36
24	207.71	58.27
25	210.24	61.37
26	212.55	64.63
27	214.64	68.05
28	215.30	69.32

Circle Center At X = 164.0 ; Y = 96.6 and Radius, 58.1

*** 2.776 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	104.63	52.37
2	107.64	49.73
3	110.79	47.27
4	114.07	44.98
5	117.47	42.87
6	120.98	40.95
7	124.59	39.22
8	128.29	37.69
9	132.06	36.37
10	135.90	35.25
11	139.79	34.34
12	143.73	33.64
13	147.70	33.16
14	151.70	32.90
15	155.70	32.85
16	159.69	33.02

17	163.67	33.40
18	167.63	34.00
19	171.54	34.82
20	175.41	35.85
21	179.21	37.08
22	182.95	38.52
23	186.59	40.16
24	190.15	42.00
25	193.60	44.03
26	196.93	46.24
27	200.14	48.63
28	203.21	51.19
29	206.14	53.91
30	208.92	56.79
31	211.54	59.81
32	213.99	62.97
33	216.26	66.26
34	218.36	69.67
35	218.53	70.00

Circle Center At X = 154.6 ; Y = 106.5 and Radius, 73.6

*** 2.779 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	125.16	53.42
2	128.83	51.84
3	132.57	50.42
4	136.37	49.16
5	140.22	48.06
6	144.10	47.13
7	148.03	46.36
8	151.99	45.77
9	155.96	45.34
10	159.95	45.08
11	163.95	44.99
12	167.95	45.07
13	171.94	45.33
14	175.92	45.75
15	179.88	46.34
16	183.81	47.10
17	187.70	48.03
18	191.54	49.12
19	195.34	50.37
20	199.08	51.79
21	202.76	53.36
22	206.37	55.09
23	209.90	56.98
24	213.34	59.01
25	216.70	61.18
26	219.96	63.50
27	223.12	65.95
28	226.17	68.54
29	227.75	70.00

Circle Center At X = 164.0 ; Y = 138.8 and Radius, 93.8

*** 2.783 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	153.90	54.89
2	157.25	52.72
3	160.82	50.91
4	164.56	49.49
5	168.42	48.46
6	172.38	47.84
7	176.37	47.64
8	180.36	47.86
9	184.31	48.49
10	188.17	49.54
11	191.91	50.98
12	195.47	52.80
13	198.81	54.99
14	201.92	57.52
15	204.74	60.35
16	207.24	63.47
17	209.41	66.83
18	210.00	68.00

Circle Center At X = 176.3 ; Y = 85.8 and Radius, 38.2

*** 2.785 ***

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	51.10
2	83.60	49.36
3	87.26	47.74
4	90.96	46.22
5	94.71	44.82
6	98.49	43.54
7	102.32	42.37
8	106.18	41.32
9	110.07	40.39
10	113.99	39.58
11	117.93	38.89
12	121.89	38.32
13	125.86	37.87
14	129.85	37.54
15	133.84	37.34
16	137.84	37.26
17	141.84	37.30
18	145.84	37.47

19	149.83	37.75
20	153.81	38.16
21	157.77	38.70
22	161.72	39.35
23	165.64	40.12
24	169.54	41.02
25	173.41	42.03
26	177.25	43.16
27	181.05	44.41
28	184.81	45.78
29	188.52	47.26
30	192.19	48.85
31	195.81	50.55
32	199.38	52.37
33	202.88	54.29
34	206.33	56.32
35	209.71	58.46
36	213.03	60.69
37	216.27	63.03
38	219.44	65.47
39	222.54	68.00
40	224.84	70.00

Circle Center At X = 138.5 ; Y = 167.6 and Radius, 130.3

*** 2.786 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	100.53	52.16
2	103.89	50.00
3	107.36	48.00
4	110.92	46.18
5	114.57	44.53
6	118.29	43.07
7	122.08	41.78
8	125.92	40.69
9	129.82	39.78
10	133.75	39.06
11	137.72	38.54
12	141.71	38.20
13	145.70	38.07
14	149.70	38.13
15	153.70	38.38
16	157.67	38.83
17	161.62	39.47
18	165.53	40.30
19	169.40	41.32
20	173.21	42.53
21	176.96	43.93
22	180.64	45.50
23	184.23	47.25
24	187.74	49.18
25	191.15	51.27
26	194.45	53.53
27	197.64	55.95

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   28         200.70       58.52
   29         203.64       61.23
   30         206.44       64.09
   31         209.10       67.07
   32         209.81       67.95
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Circle Center At X =  146.5 ; Y =  120.1  and Radius,   82.0

      ***     2.788   ***
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           Y           A     X     I     S           F     T

           0.00     43.50     87.00    130.50    174.00    217.50

X      0.00 +------*--+*--------+---------+---------+---------+
            -
            -
            -
            -          *
            -
      43.50 +
            -
            -
            -
            -
            -         ..*
A     87.00 +      ....9.
            -    .....99.
            -   ......901
            -  ......9.11
            -  ......911.
            - .......61.3
X    130.50 + ......61235
            - ......6125.
            - ......6137..
            - ......61.7.*
            - ......617.**
            -  .....6128..
I    174.00 + .....*6117..
            - .......317.*.
            - .......6318...
            - ........3218..
            - .........32110
            - ..........32111
S    217.50 + ...........32**
            -  ............3*
            -  ..........W...
            -  ..............
            -   .............
            -   .............
     261.00 +    ...........*
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            -       .........
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F    304.50 +         .......
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T     348.00 +              W  *
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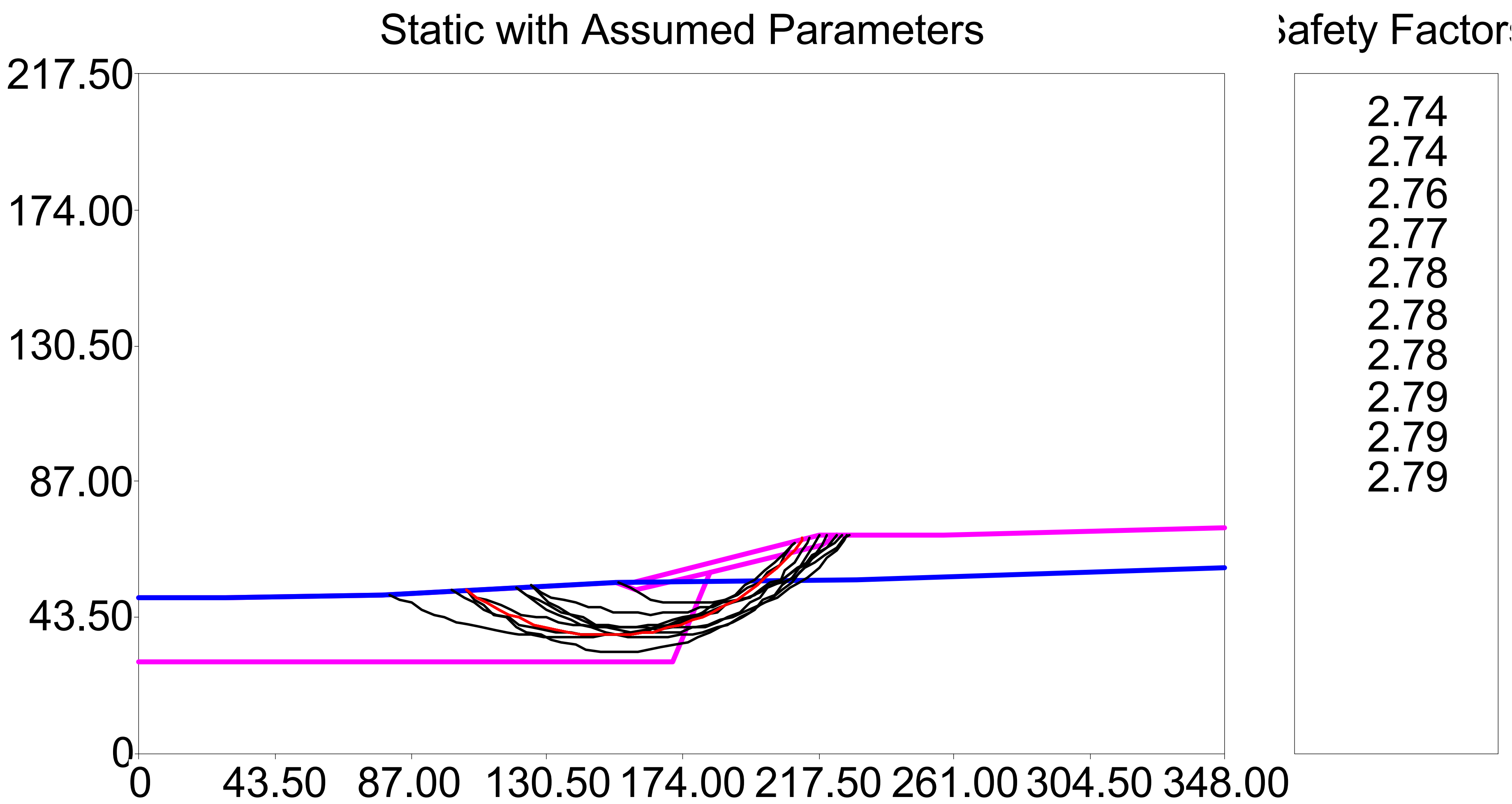

Static with Assumed Parameters
Safety Factors
217.50
174.00
130.50
87.00
43.50
0
0
43.50
87.00
130.50
174.00
217.50
261.00
304.50
348.00
2.74
2.74
2.76
2.77
2.78
2.78
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2.79
2.79
2.79

ATTACHMENT 2

DYNAMIC STABILITY ANALYSIS RESULTS

(12 pages)

** PCSTABL6 **

by
Purdue University

modified by
Peter J. Bosscher
University of Wisconsin-Madison

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

PROBLEM DESCRIPTION   Dynamic with Assumed Parameters

BOUNDARY COORDINATES

8 Top   Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	50.00	28.00	50.00	1
2	28.00	50.00	78.00	51.00	1
3	78.00	51.00	154.00	54.90	1
4	154.00	54.90	158.00	55.00	2
5	158.00	55.00	218.00	70.00	2
6	218.00	70.00	223.00	70.00	2
7	223.00	70.00	258.00	70.00	3
8	258.00	70.00	348.00	72.00	3
9	153.00	54.90	159.00	52.00	1
10	159.00	52.00	183.00	58.00	1
11	183.00	58.00	219.00	67.00	3
12	219.00	67.00	223.00	70.00	3
13	0.00	29.00	171.00	29.00	3
14	171.00	29.00	183.00	58.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion Intercept	Friction Angle	Pore Pressure	Pressure Constant	Piez. Surface

No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	115.0	115.0	400.0	0.0	0.00	0.0	0
2	135.0	135.0	0.0	40.0	0.00	0.0	0
3	120.0	120.0	0.0	30.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	50.00
2	28.00	50.00
3	78.00	51.00
4	153.00	54.90
5	230.00	55.50
6	348.00	60.00

A Horizontal Earthquake Loading Coefficient
Of0.200 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 psf

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 80.00 ft.
and X = 158.00 ft.

Each Surface Terminates Between X = 180.00 ft.
and X = 340.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 10.00 ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation. The Angle Has Been Restricted Between The Angles Of -90.0 And 5.0 deg.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	51.10
2	83.09	48.57
3	86.31	46.19
4	89.64	43.97
5	93.07	41.92
6	96.61	40.04
7	100.23	38.34
8	103.93	36.82
9	107.70	35.49
10	111.53	34.34
11	115.41	33.39
12	119.34	32.62
13	123.30	32.06
14	127.28	31.69
15	131.28	31.51
16	135.28	31.54
17	139.27	31.76
18	143.25	32.18
19	147.20	32.79
20	151.12	33.60
21	154.99	34.60
22	158.81	35.80
23	162.57	37.18
24	166.25	38.74
25	169.85	40.48
26	173.36	42.40
27	176.77	44.49
28	180.07	46.75
29	183.26	49.17
30	186.32	51.74
31	189.25	54.46
32	192.05	57.32
33	194.70	60.32
34	197.20	63.44
35	198.39	65.10

Circle Center At X = 132.8 ; Y = 112.4 and Radius, 80.9

*** 0.971 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	88.21	51.52
2	91.24	48.91
3	94.41	46.47
4	97.71	44.21
5	101.13	42.13
6	104.66	40.26
7	108.29	38.58
8	112.01	37.11
9	115.81	35.85
10	119.67	34.81
11	123.58	33.99
12	127.54	33.38
13	131.52	33.00
14	135.52	32.84
15	139.52	32.91
16	143.51	33.20
17	147.47	33.72
18	151.40	34.45
19	155.29	35.41
20	159.11	36.58
21	162.87	37.96
22	166.54	39.56
23	170.11	41.35
24	173.58	43.35
25	176.93	45.53
26	180.15	47.90
27	183.23	50.45
28	186.17	53.16
29	188.95	56.04
30	191.57	59.07
31	194.01	62.24
32	195.46	64.37

Circle Center At X = 136.3 ; Y = 104.1 and Radius, 71.3

*** 1.015 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	88.21	51.52
2	91.48	49.22
3	94.85	47.07
4	98.33	45.08
5	101.89	43.26
6	105.53	41.61
7	109.25	40.13
8	113.03	38.83
9	116.87	37.71
10	120.76	36.77

11	124.69	36.02
12	128.65	35.45
13	132.63	35.07
14	136.62	34.87
15	140.62	34.87
16	144.62	35.05
17	148.60	35.42
18	152.56	35.98
19	156.49	36.72
20	160.38	37.65
21	164.23	38.76
22	168.01	40.05
23	171.73	41.52
24	175.38	43.16
25	178.95	44.97
26	182.42	46.95
27	185.80	49.09
28	189.08	51.38
29	192.24	53.83
30	195.29	56.42
31	198.21	59.16
32	200.99	62.03
33	203.64	65.02
34	205.04	66.76

Circle Center At X = 138.7 ; Y = 119.7 and Radius, 84.9

*** 1.043 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	96.42	51.95
2	99.35	49.22
3	102.45	46.69
4	105.71	44.38
5	109.12	42.28
6	112.66	40.42
7	116.31	38.79
8	120.06	37.40
9	123.90	36.27
10	127.80	35.39
11	131.75	34.78
12	135.74	34.42
13	139.74	34.33
14	143.73	34.50
15	147.71	34.94
16	151.65	35.64
17	155.53	36.59
18	159.35	37.80
19	163.07	39.26
20	166.69	40.96
21	170.19	42.90
22	173.55	45.06
23	176.77	47.45
24	179.82	50.03
25	182.69	52.82

26	185.37	55.79
27	187.85	58.92
28	190.12	62.22
29	190.69	63.17

Circle Center At X = 139.1 ; Y = 94.9 and Radius, 60.6

*** 1.086 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	100.53	52.16
2	103.33	49.30
3	106.30	46.62
4	109.44	44.14
5	112.72	41.86
6	116.15	39.79
7	119.69	37.94
8	123.35	36.32
9	127.10	34.93
10	130.93	33.78
11	134.83	32.87
12	138.77	32.22
13	142.75	31.81
14	146.75	31.65
15	150.75	31.74
16	154.73	32.09
17	158.69	32.69
18	162.60	33.53
19	166.45	34.62
20	170.22	35.95
21	173.90	37.51
22	177.48	39.30
23	180.93	41.32
24	184.25	43.55
25	187.43	45.98
26	190.44	48.61
27	193.29	51.42
28	195.95	54.41
29	198.42	57.55
30	200.68	60.85
31	202.74	64.28
32	203.86	66.46

Circle Center At X = 147.3 ; Y = 95.1 and Radius, 63.5

*** 1.094 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	100.53	52.16
2	103.20	49.18
3	106.07	46.39
4	109.11	43.79
5	112.31	41.40
6	115.67	39.22
7	119.16	37.26
8	122.77	35.54
9	126.48	34.06
10	130.29	32.82
11	134.16	31.84
12	138.10	31.11
13	142.07	30.64
14	146.06	30.43
15	150.06	30.48
16	154.05	30.80
17	158.01	31.37
18	161.92	32.21
19	165.77	33.30
20	169.54	34.63
21	173.21	36.21
22	176.78	38.03
23	180.21	40.08
24	183.51	42.35
25	186.65	44.82
26	189.62	47.50
27	192.41	50.37
28	195.00	53.41
29	197.39	56.62
30	199.57	59.98
31	201.52	63.47
32	202.82	66.21

Circle Center At X = 147.3 ; Y = 91.5 and Radius, 61.1

*** 1.102 ***

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	51.10
2	83.60	49.36
3	87.26	47.74
4	90.96	46.22
5	94.71	44.82
6	98.49	43.54
7	102.32	42.37
8	106.18	41.32
9	110.07	40.39
10	113.99	39.58
11	117.93	38.89
12	121.89	38.32
13	125.86	37.87
14	129.85	37.54
15	133.84	37.34
16	137.84	37.26

17	141.84	37.30
18	145.84	37.47
19	149.83	37.75
20	153.81	38.16
21	157.77	38.70
22	161.72	39.35
23	165.64	40.12
24	169.54	41.02
25	173.41	42.03
26	177.25	43.16
27	181.05	44.41
28	184.81	45.78
29	188.52	47.26
30	192.19	48.85
31	195.81	50.55
32	199.38	52.37
33	202.88	54.29
34	206.33	56.32
35	209.71	58.46
36	213.03	60.69
37	216.27	63.03
38	219.44	65.47
39	222.54	68.00
40	224.84	70.00

Circle Center At X = 138.5 ; Y = 167.6 and Radius, 130.3

*** 1.109 ***

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	96.42	51.95
2	99.20	49.07
3	102.14	46.35
4	105.23	43.81
5	108.45	41.45
6	111.81	39.27
7	115.29	37.29
8	118.87	35.51
9	122.55	33.94
10	126.31	32.58
11	130.14	31.44
12	134.03	30.52
13	137.97	29.82
14	141.94	29.35
15	145.94	29.10
16	149.94	29.08
17	153.93	29.29
18	157.91	29.73
19	161.85	30.39
20	165.75	31.28
21	169.60	32.39
22	173.37	33.71
23	177.06	35.25
24	180.66	37.00
25	184.15	38.94

26	187.53	41.09
27	190.78	43.42
28	193.89	45.94
29	196.85	48.62
30	199.66	51.48
31	202.29	54.48
32	204.76	57.64
33	207.03	60.93
34	209.12	64.34
35	211.01	67.86
36	211.21	68.30

Circle Center At X = 148.3 ; Y = 99.2 and Radius, 70.1

*** 1.114 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	92.32	51.73
2	94.90	48.68
3	97.71	45.83
4	100.71	43.19
5	103.90	40.77
6	107.25	38.59
7	110.76	36.67
8	114.39	35.00
9	118.14	33.61
10	121.98	32.49
11	125.89	31.65
12	129.86	31.10
13	133.85	30.85
14	137.85	30.88
15	141.84	31.21
16	145.79	31.82
17	149.68	32.73
18	153.50	33.91
19	157.23	35.37
20	160.84	37.10
21	164.31	39.09
22	167.63	41.32
23	170.77	43.79
24	173.73	46.49
25	176.48	49.39
26	179.01	52.48
27	181.32	55.76
28	183.37	59.19
29	184.62	61.65

Circle Center At X = 135.4 ; Y = 85.6 and Radius, 54.8

*** 1.118 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	100.53	52.16
2	103.89	50.00
3	107.36	48.00
4	110.92	46.18
5	114.57	44.53
6	118.29	43.07
7	122.08	41.78
8	125.92	40.69
9	129.82	39.78
10	133.75	39.06
11	137.72	38.54
12	141.71	38.20
13	145.70	38.07
14	149.70	38.13
15	153.70	38.38
16	157.67	38.83
17	161.62	39.47
18	165.53	40.30
19	169.40	41.32
20	173.21	42.53
21	176.96	43.93
22	180.64	45.50
23	184.23	47.25
24	187.74	49.18
25	191.15	51.27
26	194.45	53.53
27	197.64	55.95
28	200.70	58.52
29	203.64	61.23
30	206.44	64.09
31	209.10	67.07
32	209.81	67.95

Circle Center At X = 146.5 ; Y = 120.1 and Radius, 82.0

*** 1.131 ***

```
           Y            A     X     I     S           F     T

           0.00     43.50     87.00    130.50    174.00    217.50

X      0.00 +------*--+*--------+---------+---------+---------+
            -
            -
            -
            -          *
            -
      43.50 +
            -
            -
            -
            -
```

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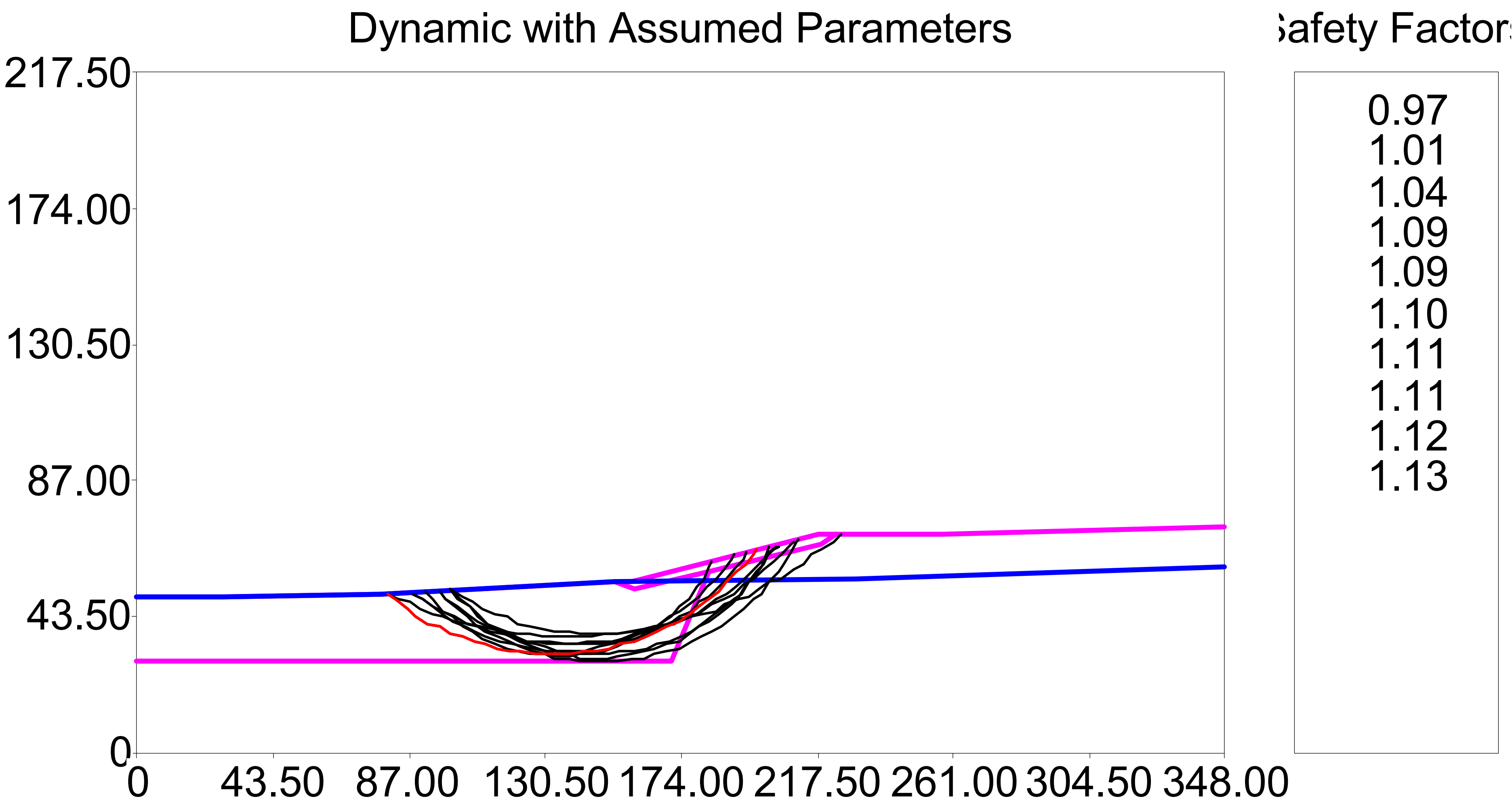
                 -          .1*
A         87.00  +       ...112
                 -     ....1124
                 -    ....11245
                 -   .....1235.
                 -   ....1135..
                 -  .....1240..
X        130.50  +  .....127...
                 -  .....127...
                 -  .....117....
                 -  .....517...*
                 -  .....611..**
                 -   ....8512...
I        174.00  +  .....*6514..
                 -  .......5312*9
                 -  .......8631124
                 -  .........73311
                 -  ..........7733
                 -  ...........7788
S        217.50  +  ............7**
                 -   ............*
                 -   ..........W...
                 -   ..............
                 -    .............
                 -    .............
         261.00  +     ..........*
                 -     ............
                 -      ...........
                 -       ..........
                 -        .........
                 -         ........
F        304.50  +          .......
                 -           ......
                 -            .....
                 -             ....
                 -               ..
                 -                ..
T        348.00  +             W   *
```



Dynamic with Assumed Parameters
217.50
174.00
130.50
87.00
43.50
0
0
43.50
87.00
130.50
174.00
217.50
261.00
304.50
348.00
Safety Factors
0.97
1.01
1.04
1.09
1.09
1.10
1.11
1.11
1.12
1.13

ATTACHMENT 3

NEWMARK ANALYSIS RESULTS BY 3 METHODS

(7 pages)

Newmark Method 1 Calculation (1 page)

Newmark

Getting Started | Rigorous Rigid-Block Analysis | Simplified Analyses | Record Manager | Utilities | Help

Rigid-Block Analysis | Decoupled Analysis

(•) Ambraseys and Menu ( ) Jibson and Others ( ) Probability of Failure

What is the critical (yield) acceleration (in g's)?

0.2 g

What is the peak ground acceleration (in g's)?

0.5 g

Perform Analysis

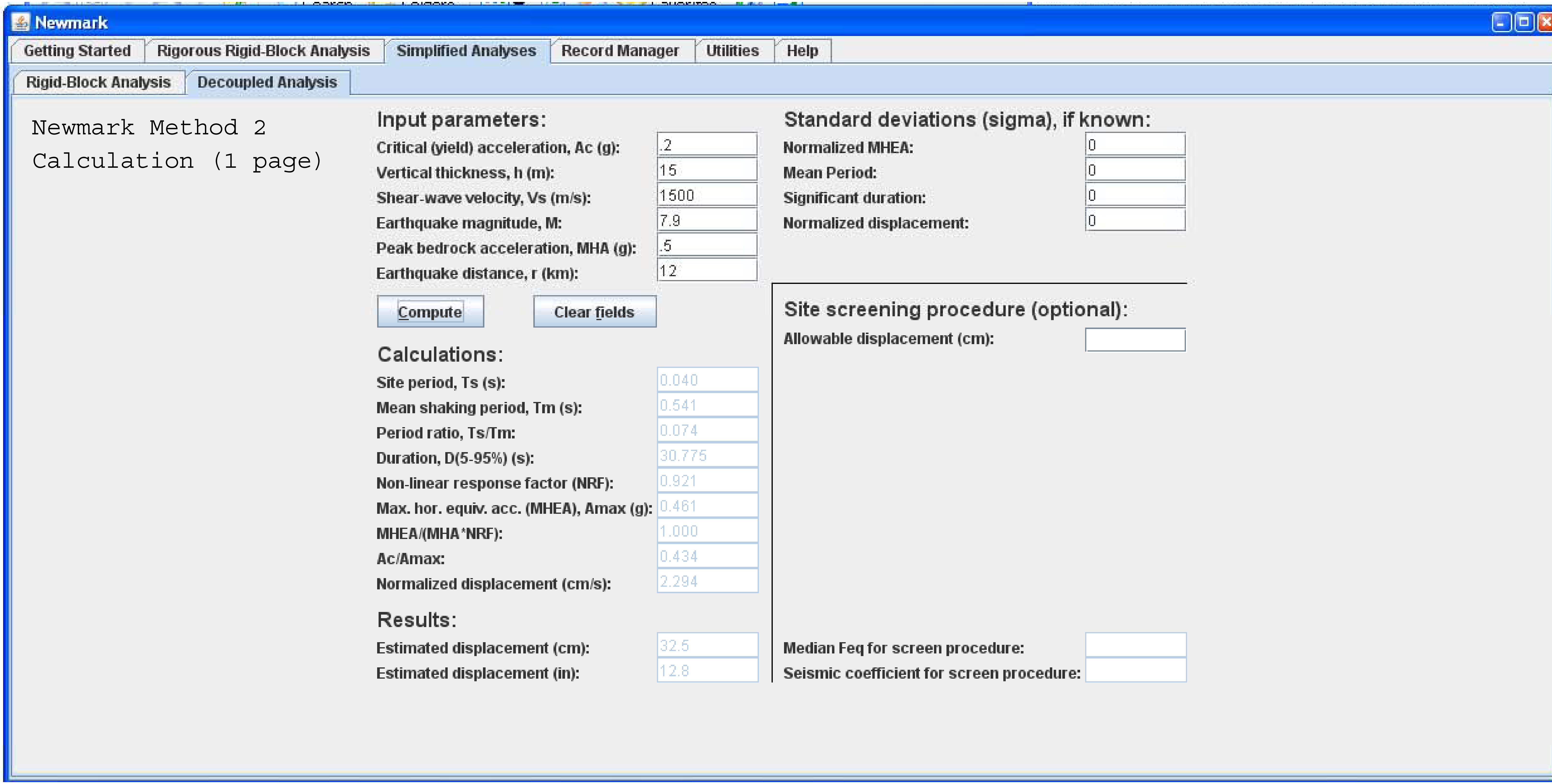
Estimated Newmark Displacement (in cm)
5.9

Result = 5.9 cm

This program estimates rigid-block Newmark displacement as a function of the critical acceleration and peak ground acceleration using the following equation as explained in Ambraseys and Menu (1988):

$$\log D_n = 0.90 + \log[\,(1 - a_c / a_{max})^{2.53}\,(a_c / a_{max})^{-1.09}\,]$$

where D_n is Newmark displacement in centimeters, a_c is critical (yield) acceleration in g's, and a_{max} is the peak horizontal ground acceleration in g's.


Newmark
Getting Started
Rigorous Rigid-Block Analysis
Simplified Analyses
Record Manager
Utilities
Help
Rigid-Block Analysis
Decoupled Analysis
Newmark Method 2 Calculation (1 page)
Input parameters:
Critical (yield) acceleration, Ac (g): .2
Vertical thickness, h (m): 15
Shear-wave velocity, Vs (m/s): 1500
Earthquake magnitude, M: 7.9
Peak bedrock acceleration, MHA (g): .5
Earthquake distance, r (km): 12
Compute
Clear fields
Calculations:
Site period, Ts (s): 0.040
Mean shaking period, Tm (s): 0.541
Period ratio, Ts/Tm: 0.074
Duration, D(5-95%) (s): 30.775
Non-linear response factor (NRF): 0.921
Max. hor. equiv. acc. (MHEA), Amax (g): 0.461
MHEA/(MHA*NRF): 1.000
Ac/Amax: 0.434
Normalized displacement (cm/s): 2.294
Results:
Estimated displacement (cm): 32.5
Estimated displacement (in): 12.8
Standard deviations (sigma), if known:
Normalized MHEA: 0
Mean Period: 0
Significant duration: 0
Normalized displacement: 0
Site screening procedure (optional):
Allowable displacement (cm):
Median Feq for screen procedure:
Seismic coefficient for screen procedure:

Newmark

Getting Started | Rigorous Rigid-Block Analysis | Simplified Analyses | Record Manager | Utilities | Help

Step 1: Select Records | Step 2: Perform Rigid-Block Analysis | Step 3: View Results

Search records by properties | Select individual records

Newmark Method 3 Calculation (5 pages)

Step 1: Selected earthquake records that are strike-slip and soft soil.

	Greater than or equal to:	Less than or equal to:
Moment Magnitude		
Arias Intensity (m/s)		
Duration (5-95%) (s)		
Peak Acceleration (g)		
Mean Period (s)		
Epicentral Distance (km)		
Focal Distance (km)		
Rupture Distance (km)		

Search for records

Clear all search fields

Search complete. 22 records found.

Focal Mechanism: ☐ All ☑ Strike-slip ☐ Normal ☐ Reverse ☐ Oblique normal ☐ Oblique reverse

Site Classification: ☐ All ☐ Hard rock ☐ Soft rock ☐ Stiff soil ☑ Soft soil

Records selected (units as indicated above):

Select all for analysis | Deselect all for analysis

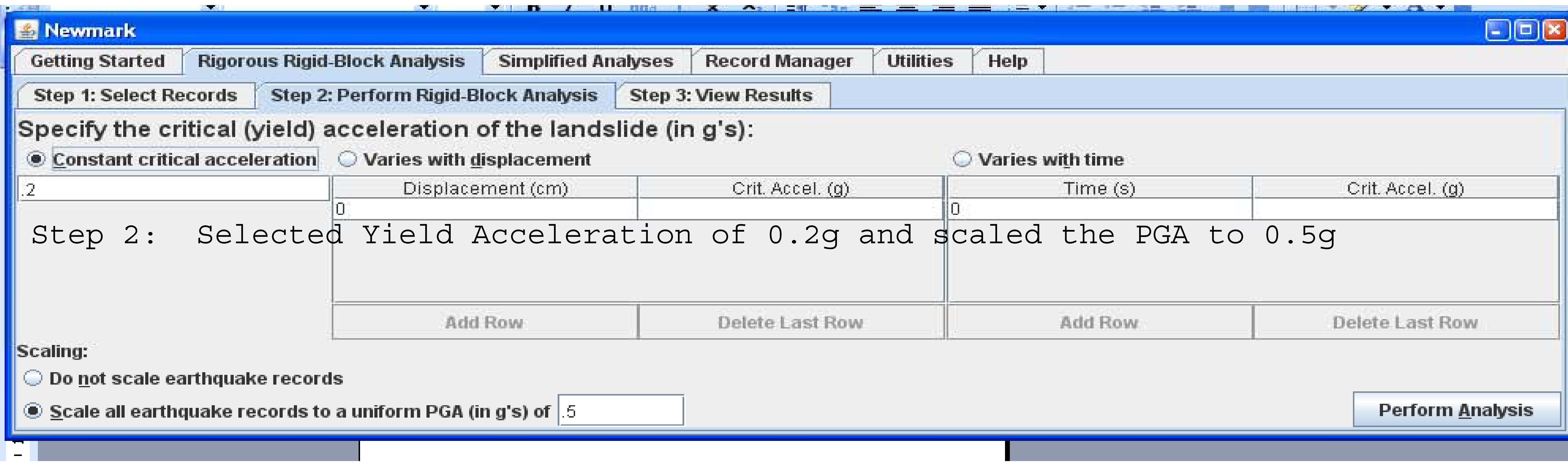
Sort by Earthquake then Record A/A

Display properties of: ◉ Records ○ Stations

Earthquake	Record	Magnitude	Arias Int.	Duration	PGA	Mean Per.	Epi. Dist.	Focal Dist.	Rup. Dist	Foc. Mech.	Analyze
Imperial Valley ...	EC3-140	6.5	1.145	11.7	0.267	0.63	28.0	30.0	11.9	Strike-slip	☑
Imperial Valley ...	EC3-230	6.5	0.694	14.2	0.222	0.48	28.0	30.0	11.9	Strike-slip	☑
Kobe, Japan 19...	KAK-000	6.9	1.031	13.2	0.251	0.48	26.1	33.5	26.4	Strike-slip	☑
Kobe, Japan 19...	KAK-090	6.9	1.688	12.9	0.345	0.54	26.1	33.5	26.4	Strike-slip	☑
Kobe, Japan 19...	NIS-000	6.9	3.353	9.7	0.509	0.49	10.6	23.5	11.1	Strike-slip	☑
Kobe, Japan 19...	NIS-090	6.9	2.270	11.2	0.503	0.53	10.6	23.5	11.1	Strike-slip	☑
Kobe, Japan 19...	OSA-000	6.9	0.230	58.3	0.079	1.24	44.6	49.3	8.5	Strike-slip	☑
Kobe, Japan 19...	OSA-090	6.9	0.195	70.5	0.064	1.43	44.6	49.3	8.5	Strike-slip	☑
Kobe, Japan 19...	SHI-000	6.9	0.827	10.3	0.243	0.76	48.7	53.0	15.5	Strike-slip	☑
Kobe, Japan 19...	SHI-090	6.9	0.639	11.8	0.212	0.73	48.7	53.0	15.5	Strike-slip	☑
Kobe, Japan 19...	TAK-000	6.9	8.700	11.3	0.611	1.13	13.3	24.9	0.3	Strike-slip	☑
Kobe, Japan 19...	TAK-090	6.9	8.134	9.9	0.616	0.99	13.3	24.9	0.3	Strike-slip	☑
Kobe, Japan 19...	TAZ-000	6.9	3.071	4.6	0.693	0.80	39.1	44.4	1.2	Strike-slip	☑
Kobe, Japan 19...	TAZ-090	6.9	3.937	3.7	0.694	0.63	39.1	44.4	1.2	Strike-slip	☑
Kocaeli, Turkey ...	ATS-000	7.4	1.007	36.6	0.249	0.87	101.7	103.1	78.9	Strike-slip	☑
Kocaeli, Turkey ...	ATS-090	7.4	1.240	37.2	0.185	0.98	101.7	103.1	78.9	Strike-slip	☑
Morgan Hill 1984	A01-040	6.2	0.065	21.3	0.046	0.52	55.4	56.1	54.1	Strike-slip	☑
Morgan Hill 1984	A01-310	6.2	0.076	19.0	0.068	0.49	55.4	56.1	54.1	Strike-slip	☑
Superstition Hill...	SSW-225	6.5	0.264	12.9	0.137	0.47	18.0	21.0	25.6	Strike-slip	☑
Superstition Hill...	SSW-315	6.5	0.381	14.1	0.143	0.68	18.0	21.0	25.6	Strike-slip	☑
Westmorland 1...	SSW-225	5.8	0.523	8.4	0.199	0.40	5.9	7.1		Strike-slip	☑
Westmorland 1...	SSW-315	5.8	0.513	9.2	0.176	0.39	5.9	7.1		Strike-slip	☑

Manage groups... | Clear table | Delete highlighted record(s) | Go to Perform Rigid-Block Analysis page

22 of 22 records selected for analysis



Step 2: Selected Yield Acceleration of 0.2g and scaled the PGA to 0.5g

Newmark

Getting Started | Rigorous Rigid-Block Analysis | Simplified Analyses | Record Manager | Utilities | Help

Step 1: Select Records | Step 2: Perform Rigid-Block Analysis | Step 3: View Results

Perform Analysis | Clear output

Earthquake	Record	Displacement 1 (cm)	Displacement 2 (cm)	Average Disp. (cm)
Imperial Valley 1979	EC3-140	4.3	13.6	9.0
Imperial Valley 1979	EC3-230	5.0	3.5	4.2
Morgan Hill 1984	A01-040	16.2	11.6	13.9
Morgan Hill 1984	A01-310	1.8	4.8	3.3
Superstition Hills 1987	SSW-225	1.7	3.4	2.6
Superstition Hills 1987	SSW-315	12.2	7.9	10.0
Westmorland 1981	SSW-225	3.4	3.4	3.4
Westmorland 1981	SSW-315	7.4	6.8	7.1
Kobe, Japan 1995	KAK-000	5.3	3.7	4.5
Kobe, Japan 1995	KAK-090	6.4	2.7	4.6
Kobe, Japan 1995	NIS-000	7.0	6.3	6.6
Kobe, Japan 1995	NIS-090	2.5	3.4	3.0
Kobe, Japan 1995	OSA-000	32.0	55.8	43.9
Kobe, Japan 1995	OSA-090	34.7	27.0	30.8
Kobe, Japan 1995	SHI-000	15.5	11.1	13.3
Kobe, Japan 1995	SHI-090	13.5	8.5	11.0
Kobe, Japan 1995	TAK-000	37.7	29.5	33.6
Kobe, Japan 1995	TAK-090	34.5	24.9	29.7
Kobe, Japan 1995	TAZ-000	0.3	8.2	4.2
Kobe, Japan 1995	TAZ-090	7.0	4.5	5.8
Kocaeli, Turkey 1999	ATS-000	7.3	4.8	6.0
Kocaeli, Turkey 1999	ATS-090	35.8	39.4	37.6

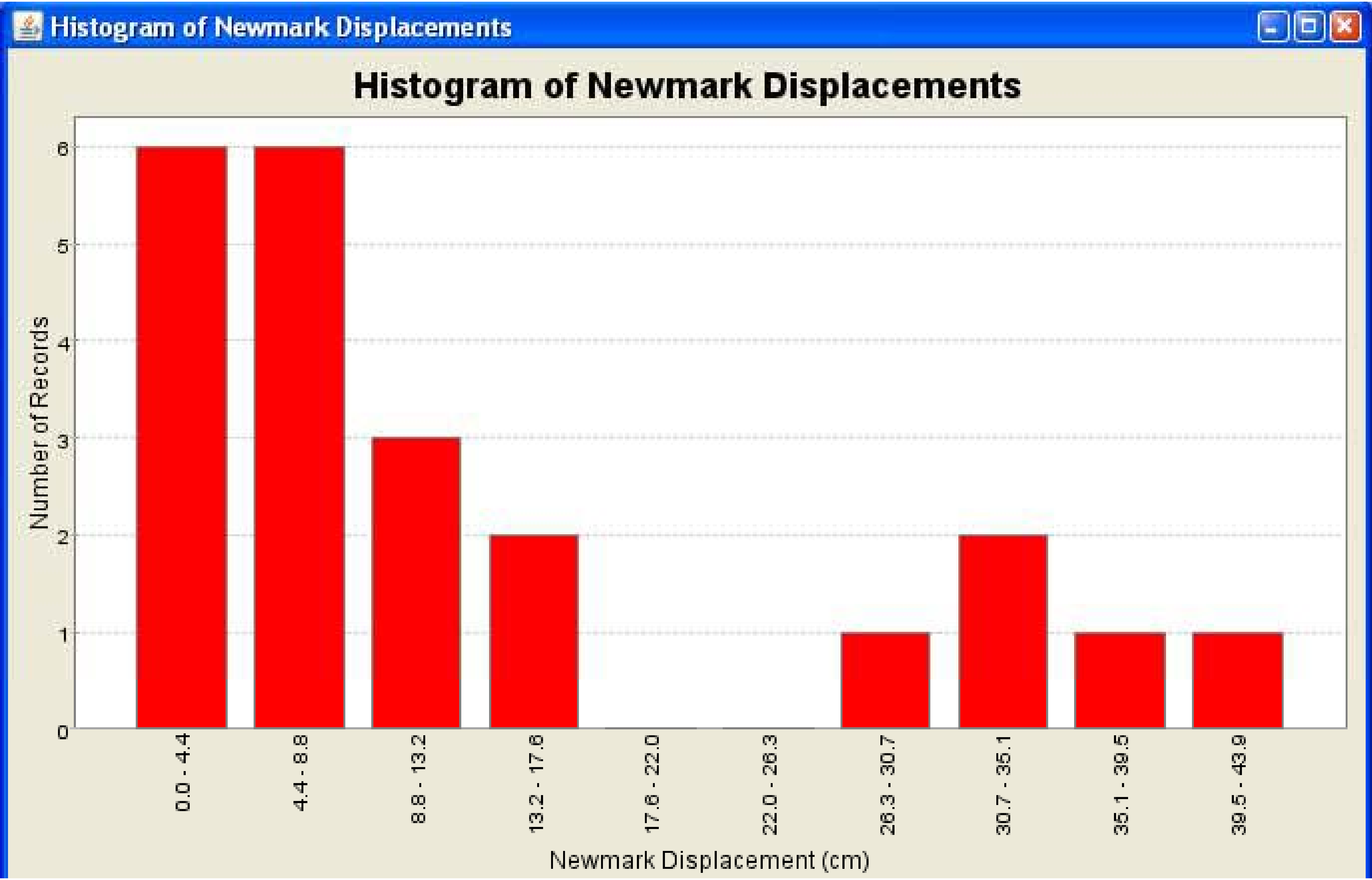
Step 3: Conduct analysis and display histogram and also displacements VS time.

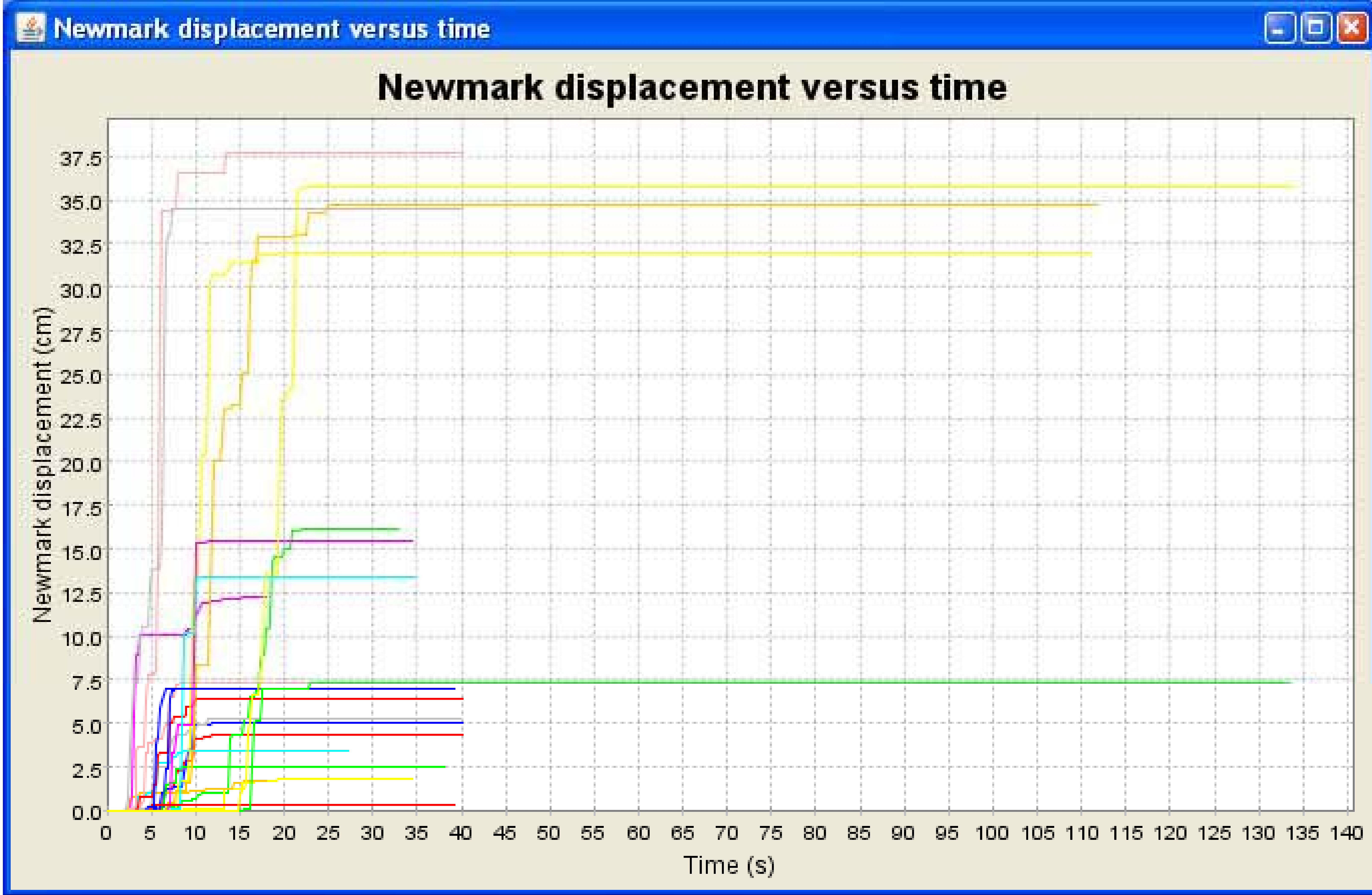
Save output | tab delimited | space delimited | comma delimited

Mean value is: 13.1 cm
Median value is: 7.1 cm
Standard Deviation is: 12.9 cm

Plot histogram of Newmark displacements | Plot with 10 bins

Plot Newmark displacements versus time | Display legend


Histogram of Newmark Displacements
Histogram of Newmark Displacements
Number of Records
0
1
2
3
4
5
6
0.0 - 4.4
4.4 - 8.8
8.8 - 13.2
13.2 - 17.6
17.6 - 22.0
22.0 - 26.3
26.3 - 30.7
30.7 - 35.1
35.1 - 39.5
39.5 - 43.9
Newmark Displacement (cm)


Newmark displacement versus time
Newmark displacement versus time
Newmark displacement (cm)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
32.5
35.0
37.5
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140
Time (s)