See Pocket 7 for encl.

ACRES

December 12, 1985
P6678.00

WM-RES
WM Record File B6985 Corstar
WM Project 10,11,16
Docket No.
PDR ✓
LPDR B,N,S
Distribution: PBrooks
(Return to WM, 623-SS)

Pauline Brooks, Project Officer
Division of Waste Management
MS 623 SS
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Pauline:

Benchmarking Computer Codes
Repository Design
ADINA and ADINAT

At the progress meeting held at the NRC offices on December 10, 1985, Bill Swanson of Acres made a presentation of our project status and results to date. At your request, I have enclosed copies of the overhead transparencies used during the presentation.

Very truly yours,

Bill Lamb

D. W. Lamb
Manager
Project Operations

DWL:sd
Enclosures

cc: D. K. Vogt (w/o enclosures)

8601170353 851212
PDR WMRES EECACRIC
B-6985 PDR

WM DOCKET CONTROL CENTER
'85 DEC 18 P2:28

ACRES INTERNATIONAL CORPORATION
Engineers, Architects and Planners
Suite 1000, Liberty Building, 424 Main Street,
Buffalo, New York 14202-3592
Telephone 716-853-7525 Telex 91-6423

2657

BENCHMARKING COMPUTER COSTS

CURRENT PROJECT STATUS

MATRIX OF PROBLEMS TO BE DONE BY ACRES

December 9, 1985

PROBLEM / CODE	THERMAL				GEOMECHANICAL				HYPOTHETICAL			VALIDATION	
	2.6	2.8	2.9	2.10	3.2a	3.2b	3.3c	3.5	5.1	5.2	5.3	6.1	6.3
ADINAT	☒	☒	☒	▲					●		●	●	☒
ADINA						☒	☒	▲	●		●	●	▲
COYOTE	☒	☒	●	▲						☒			☒
DOT	☒									☒		☒	☒
MATLOC					☒					☒			☒
SALT 4										▲	▲	☒	
VISCOT						☒	☒	▲		▲		▲	☒

☒ Complete

▲ Attempted; problems encountered

● No attempted yet

See B6985 12/12/85
Pauline Brooks
"Benchmarking Computer Codes"

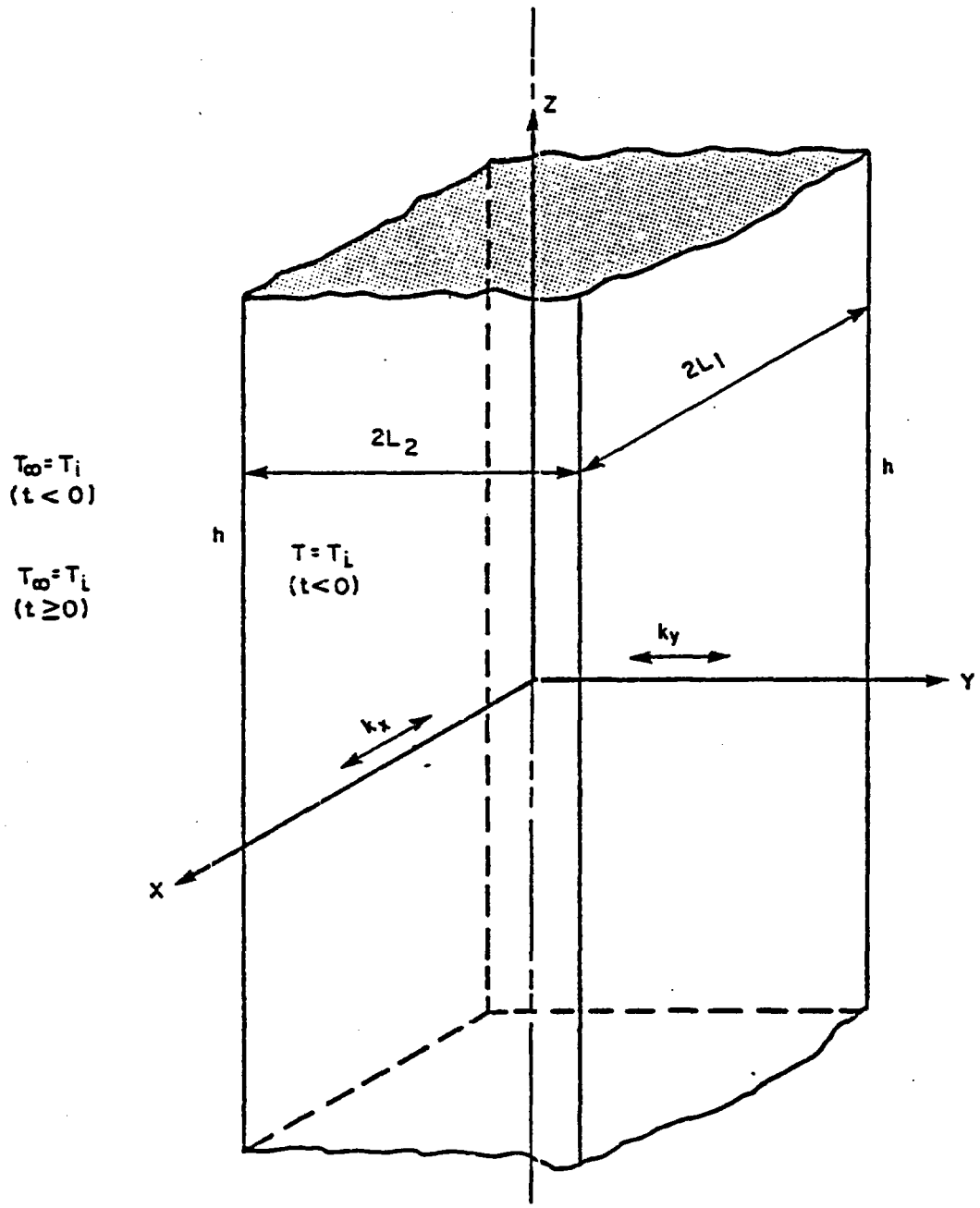
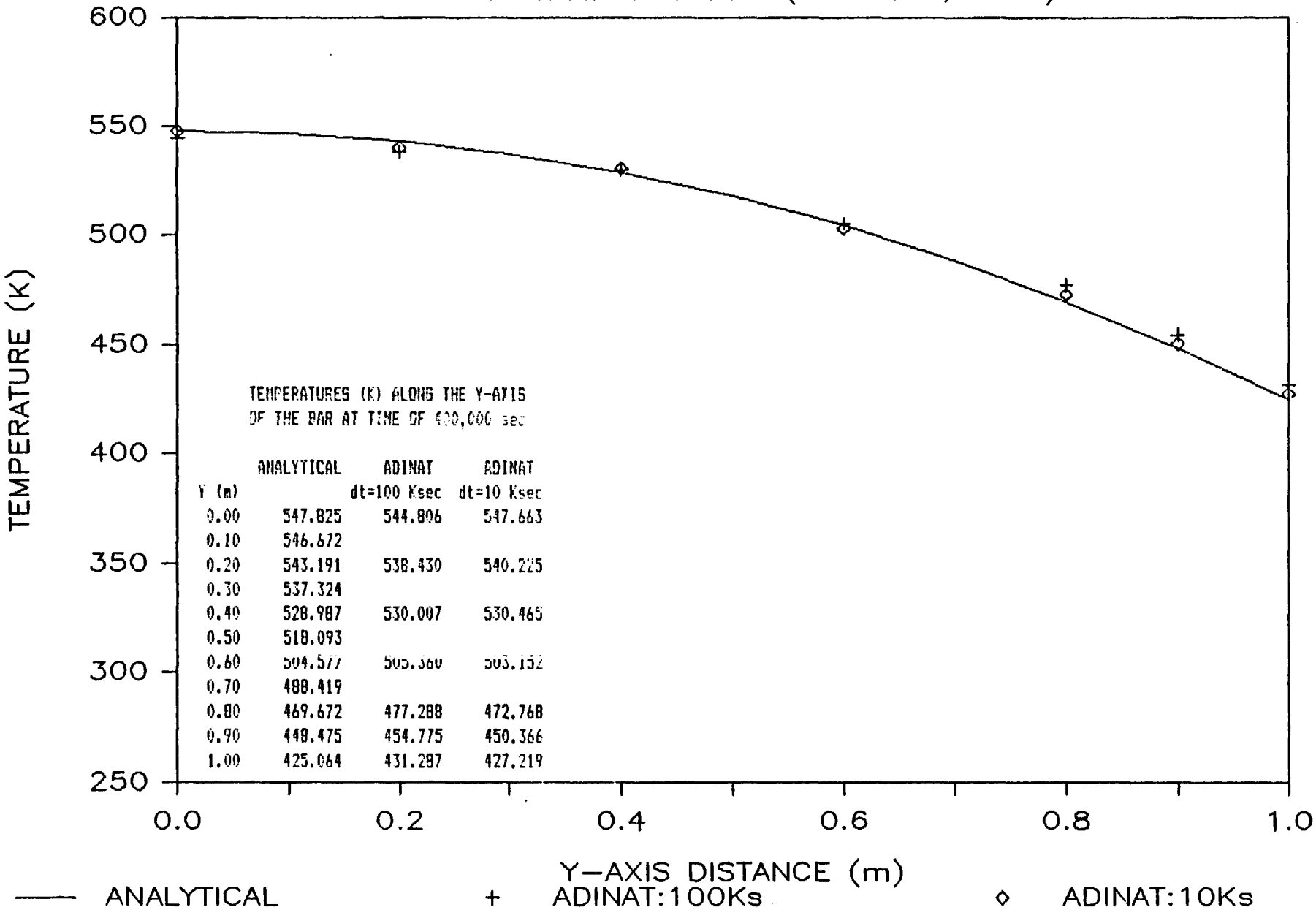


Figure 2.6-1 Rectangular Bar with Anisotropic Conductivity

ADINAT PROBLEM 2.6

Y–AXIS TEMPERATURES (at t=400,000 s)

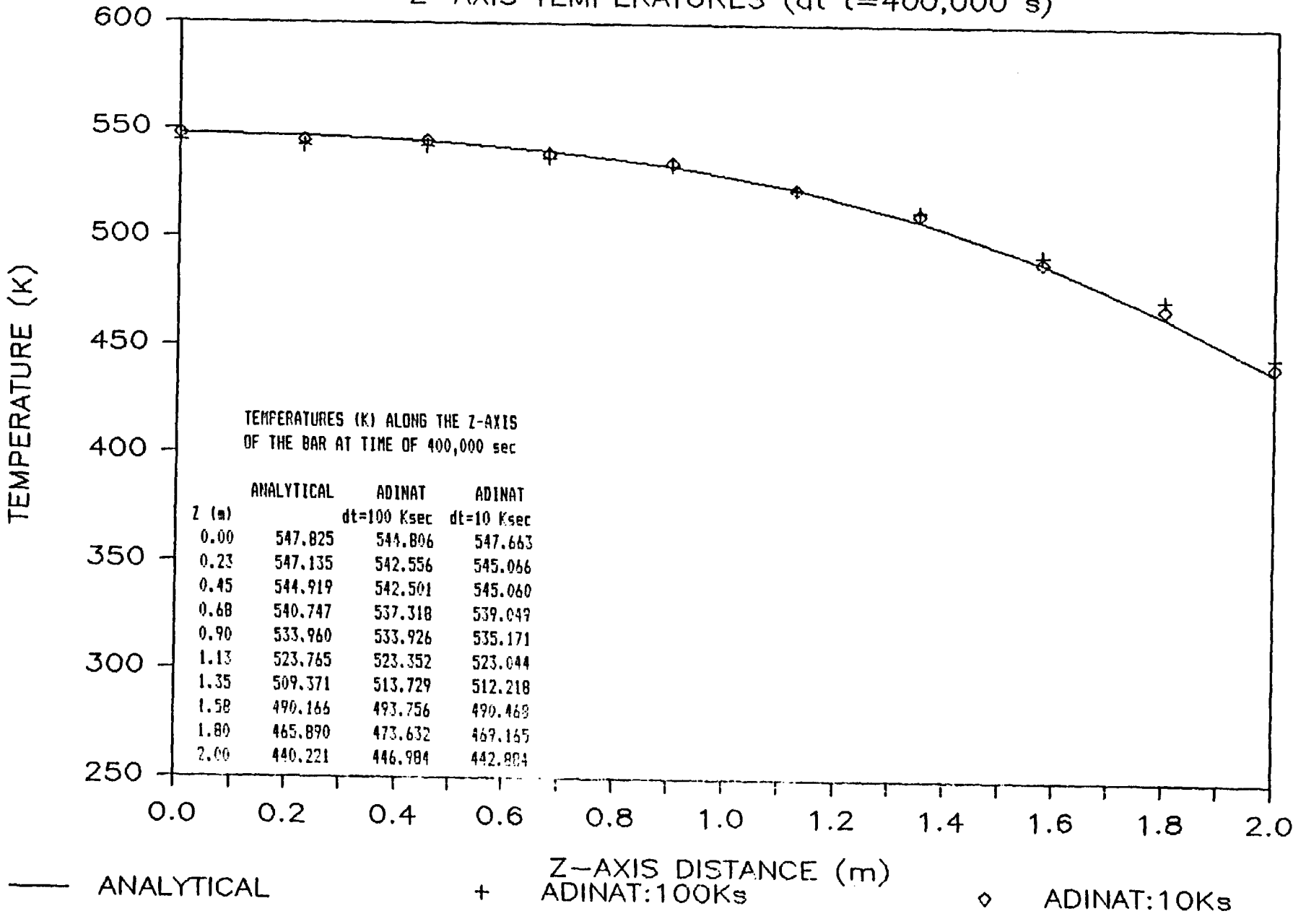


TEMPERATURES (K) ALONG THE Y-AXIS
OF THE BAR AT TIME OF 400,000 sec

Y (m)	ANALYTICAL	ADINAT dt=100 Ksec	ADINAT dt=10 Ksec
0.00	547.825	544.806	547.663
0.10	546.672		
0.20	543.191	536.430	540.225
0.30	537.324		
0.40	528.987	530.007	530.465
0.50	518.093		
0.60	504.577	505.360	503.152
0.70	488.419		
0.80	469.672	477.288	472.768
0.90	448.475	454.775	450.366
1.00	425.064	431.287	427.219

ADINAT PROBLEM 2.6

Z-AXIS TEMPERATURES (at t=400,000 s)

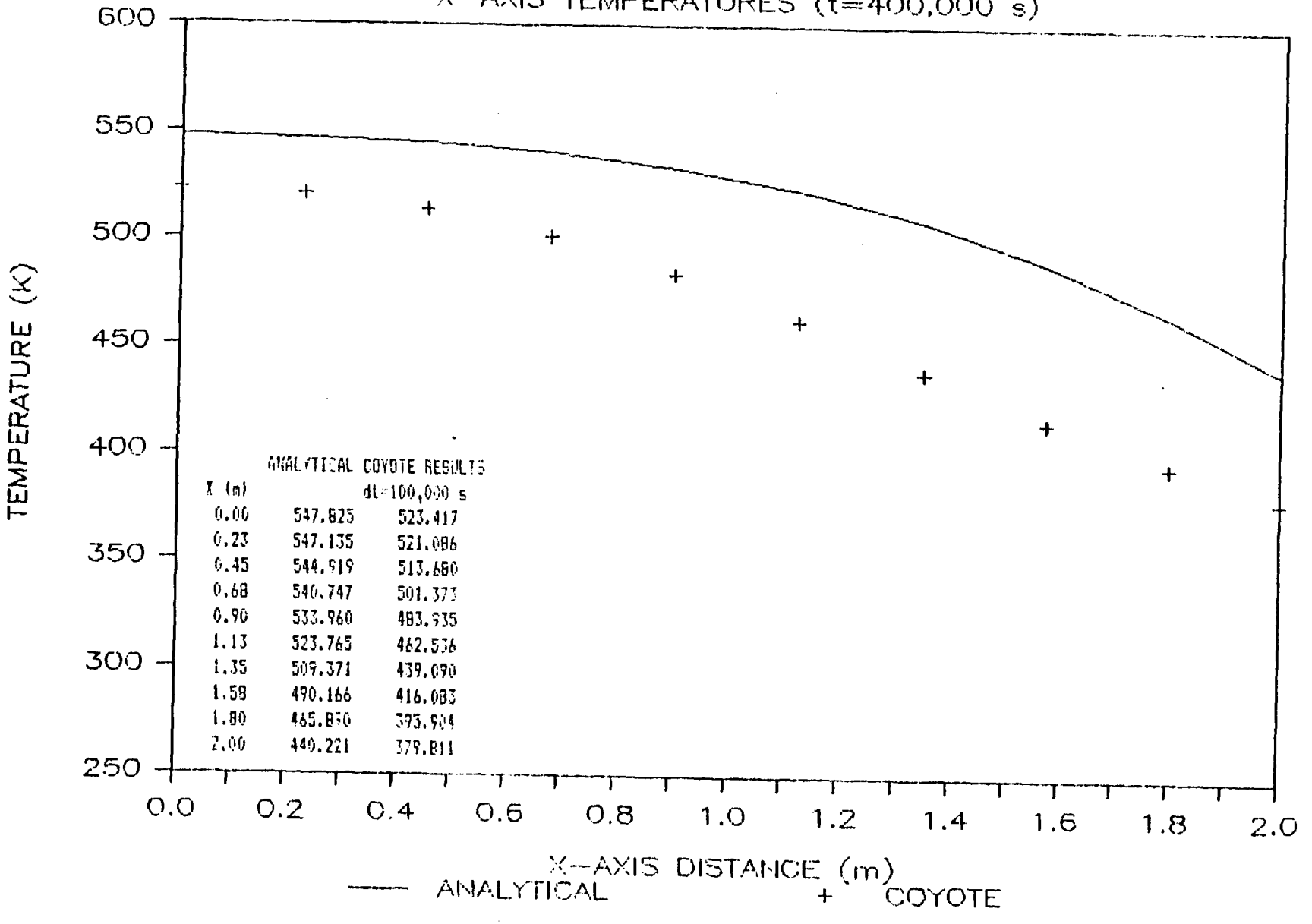


TEMPERATURES (K) ALONG THE Z-AXIS
OF THE BAR AT TIME OF 400,000 sec

Z (m)	ANALYTICAL	ADINAT dt=100 Ksec	ADINAT dt=10 Ksec
0.00	547.825	544.806	547.663
0.23	547.135	542.556	545.066
0.45	544.919	542.501	545.060
0.68	540.747	537.318	539.049
0.90	533.960	533.926	535.171
1.13	523.765	523.352	523.044
1.35	509.371	513.729	512.218
1.58	490.166	493.756	490.468
1.80	465.890	473.632	469.165
2.00	440.221	446.984	442.804

COYOTE PROBLEM 2.6

X-AXIS TEMPERATURES (t=400,000 s)

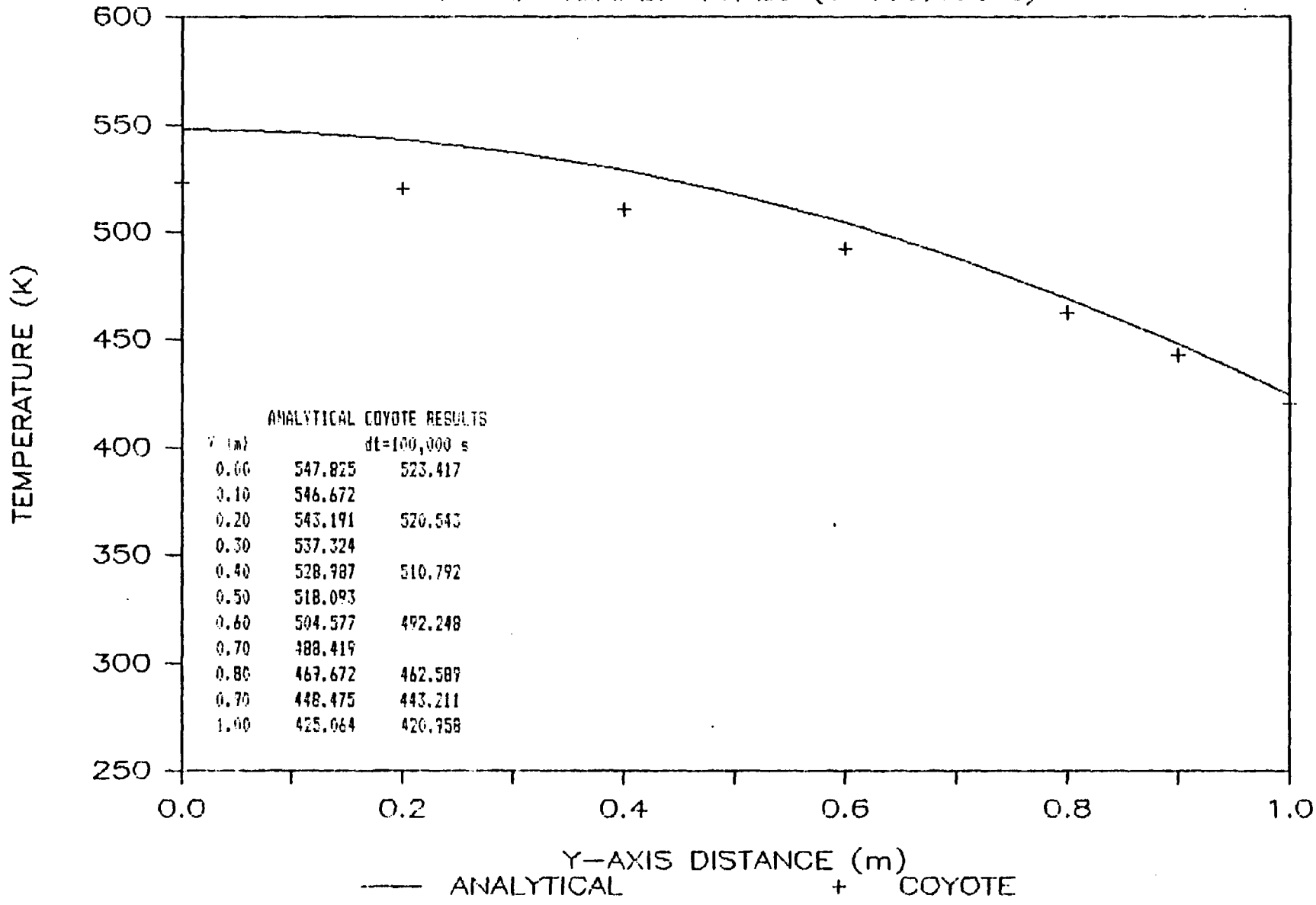


ANALYTICAL COYOTE RESULTS

X (m)		dt=100,000 s
0.00	547.825	523.417
0.23	547.135	521.086
0.45	544.919	513.680
0.68	540.747	501.373
0.90	533.960	483.935
1.13	523.765	462.536
1.35	509.371	439.090
1.58	490.166	416.083
1.80	465.850	395.904
2.00	440.221	379.811

COYOTE PROBLEM 2.6

Y-AXIS TEMPERATURES (t=400,000 s)

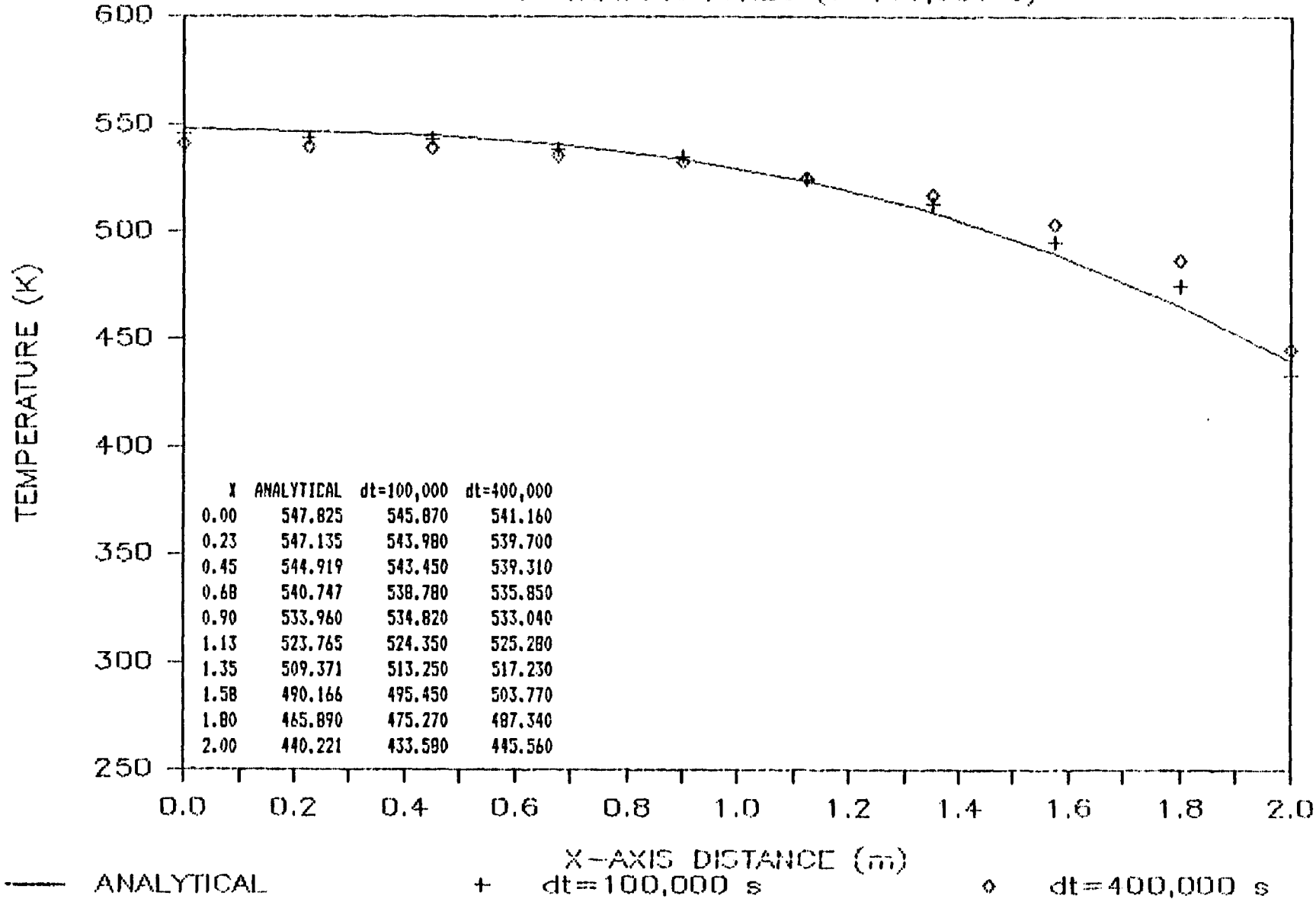


ANALYTICAL COYOTE RESULTS

Y (m)		dt=100,000 s
0.00	547.825	523.417
0.10	546.672	
0.20	543.191	520.543
0.30	537.324	
0.40	528.987	510.792
0.50	518.093	
0.60	504.577	492.248
0.70	488.419	
0.80	467.672	462.589
0.90	448.475	443.211
1.00	425.064	420.958

DOT PROBLEM 2.6

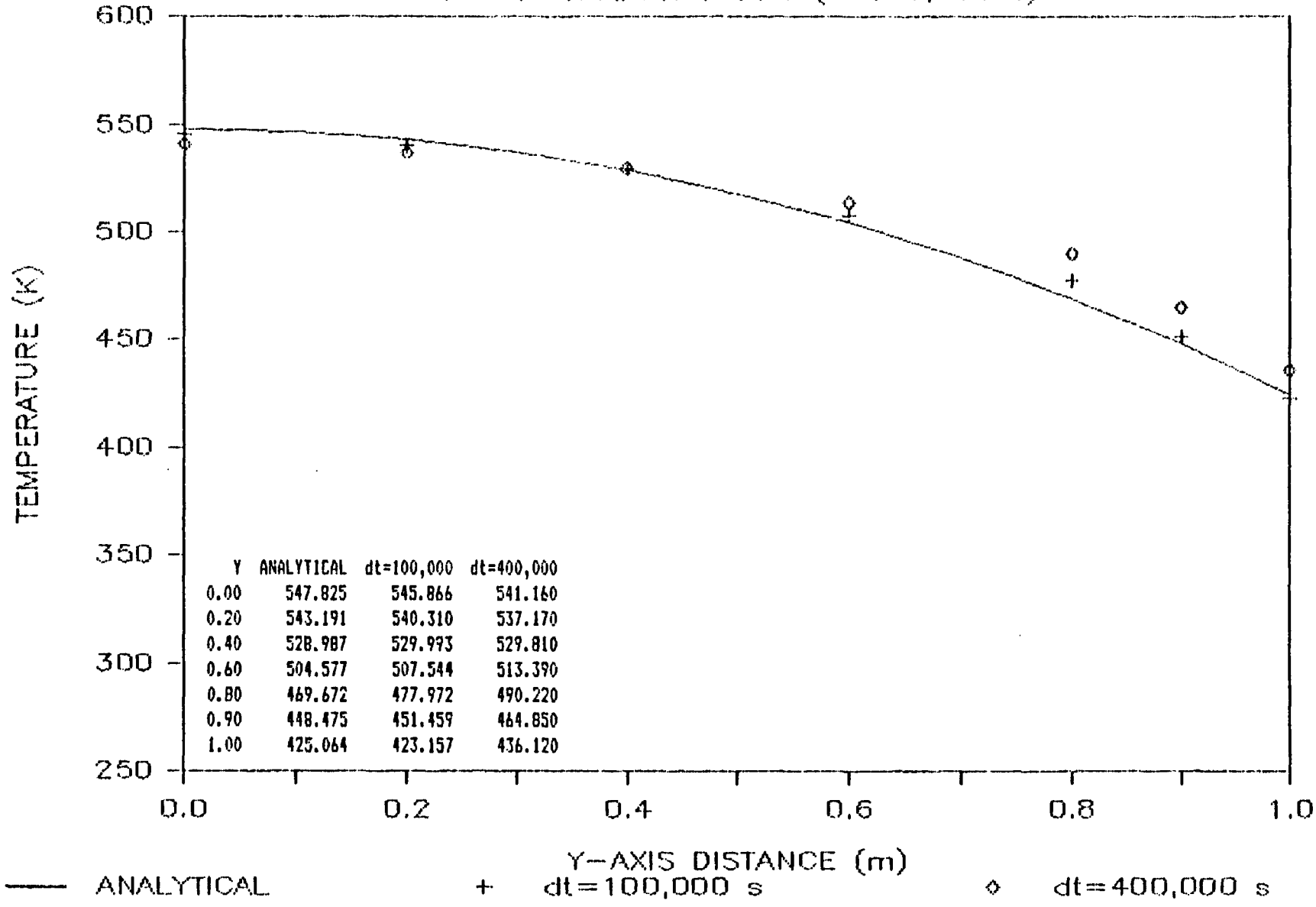
X-AXIS TEMPERATURES (t=400,000 s)



X	ANALYTICAL	dt=100,000	dt=400,000
0.00	547.825	545.870	541.160
0.23	547.135	543.980	539.700
0.45	544.919	543.450	539.310
0.68	540.747	538.780	535.850
0.90	533.960	534.820	533.040
1.13	523.765	524.350	525.280
1.35	509.371	513.250	517.230
1.58	490.166	495.450	503.770
1.80	465.890	475.270	487.340
2.00	440.221	433.590	445.560

DOT PROBLEM 2.6

Y-AXIS TEMPERATURES (t=400,000 s)



Y	ANALYTICAL	dt=100,000	dt=400,000
0.00	547.825	545.866	541.160
0.20	543.191	540.310	537.170
0.40	528.987	529.993	529.810
0.60	504.577	507.544	513.390
0.80	469.672	477.972	490.220
0.90	448.475	451.459	464.850
1.00	425.064	423.157	436.120

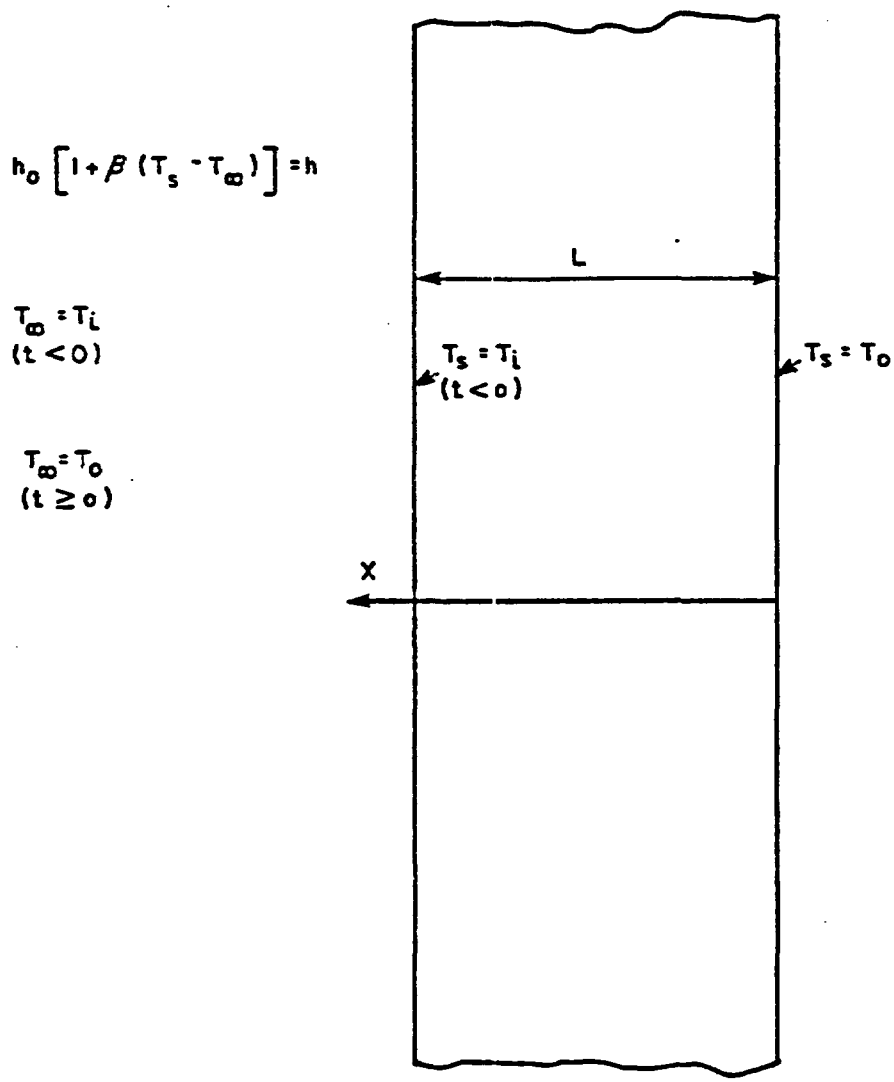


Figure 2.8-1 Transient Response to the Quench of an Infinite Slab with a Temperature-Dependent Convection Coefficient

Problem 2.8

Temperature Results Comparison

TIME (hr)	Surface Temperature (°C)		
	Analytical	COYOTE	ADINAT
0.0	260	260.0	260.0
2.3	174	166.5	174.1
4.6	154	149.4	155.2
7.0	141	137.6	142.3

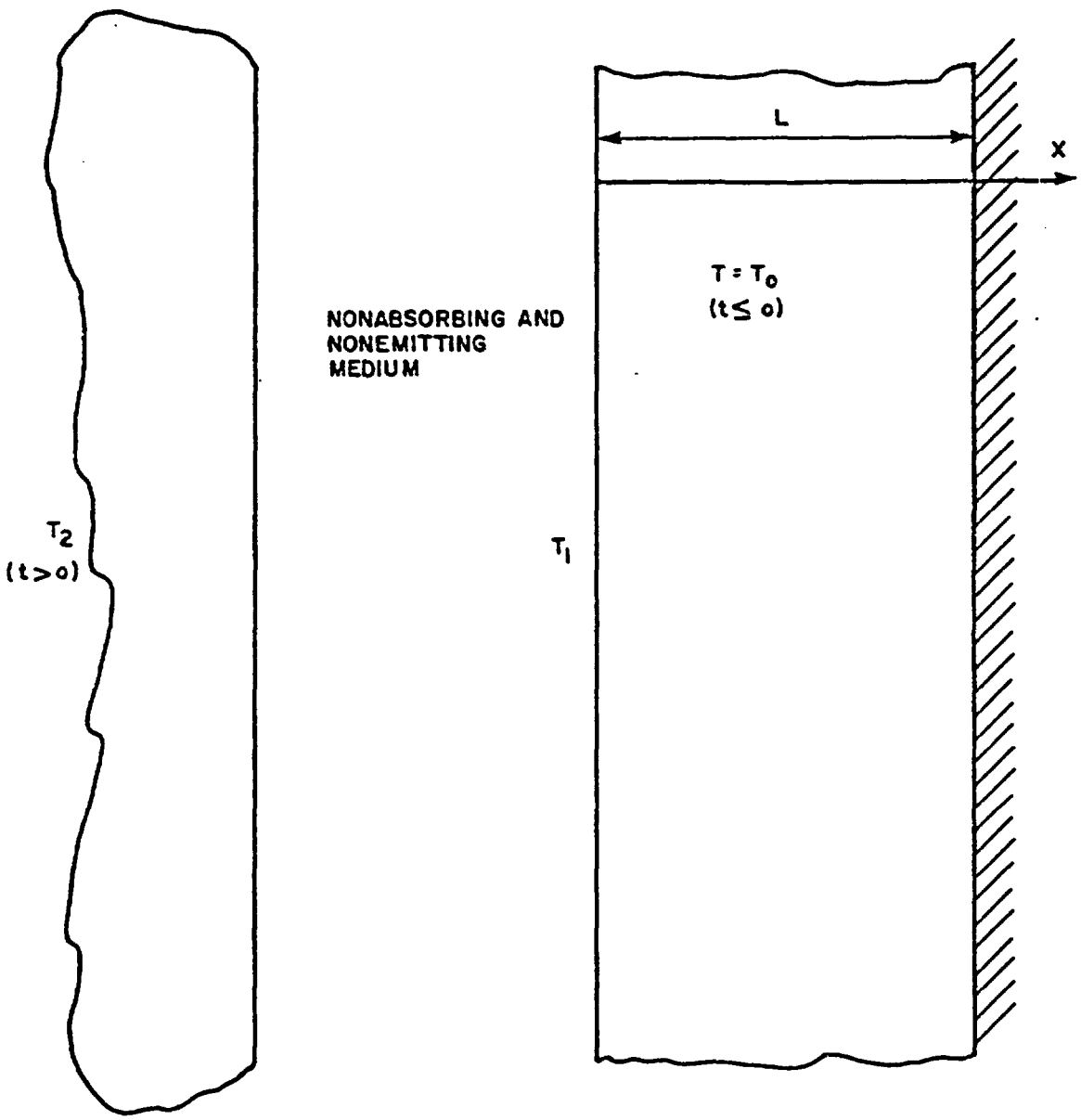
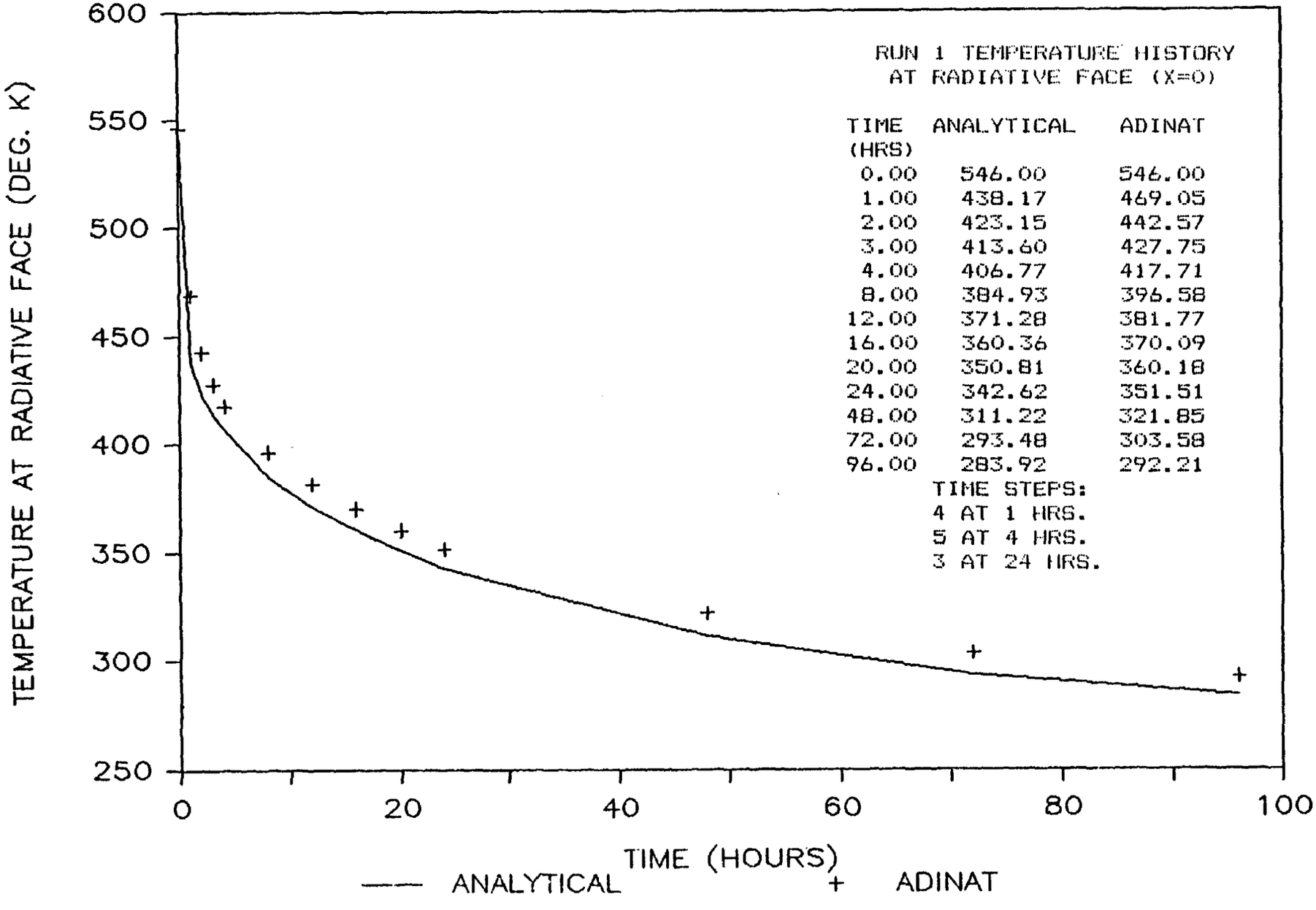


Figure 2.9-1 Radiation from a Slab

ADINAT – PROBLEM 2.9 (RUN #1)

TEMPERATURE HISTORY AT X=0



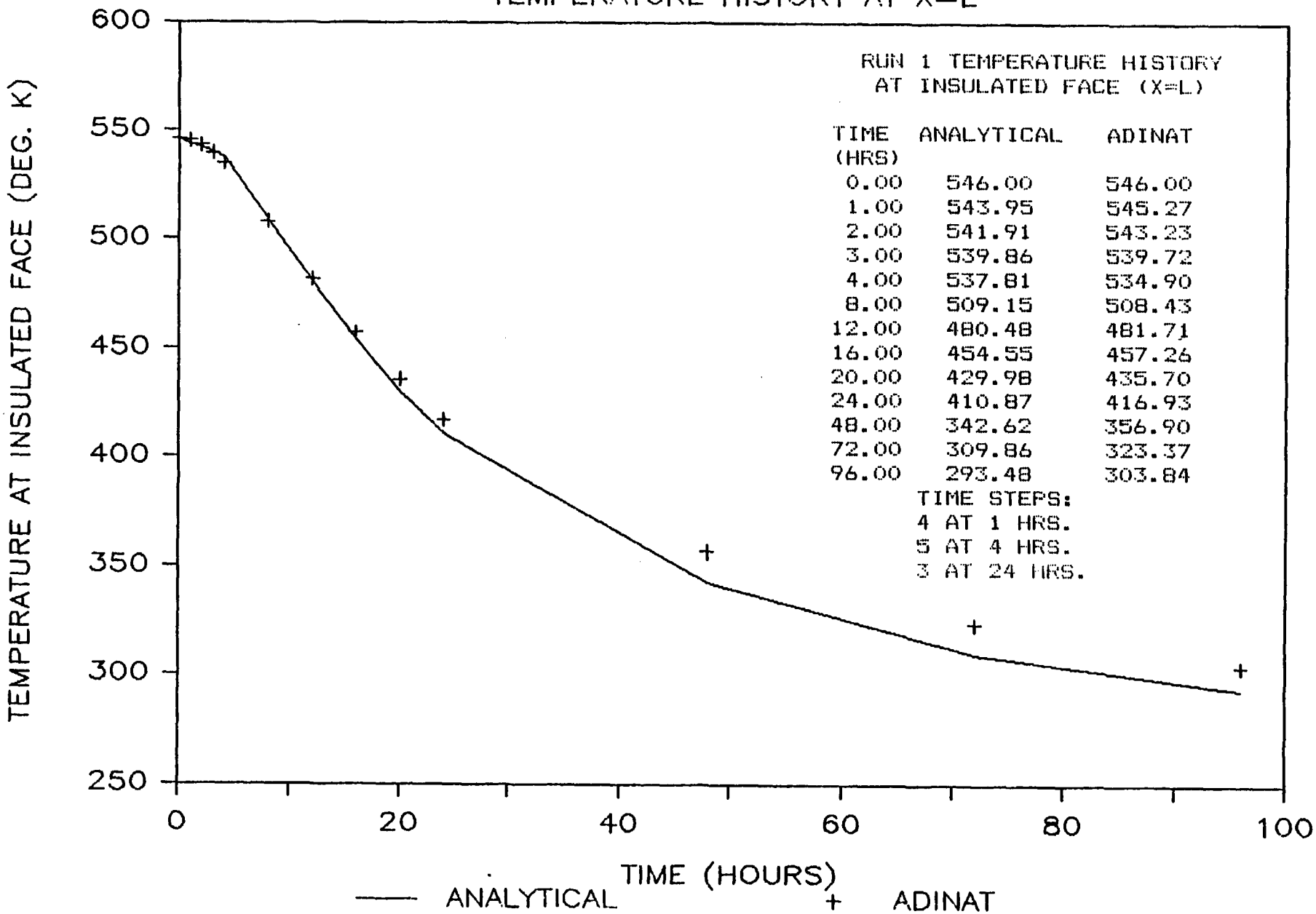
RUN 1 TEMPERATURE HISTORY
AT RADIATIVE FACE (X=0)

TIME (HRS)	ANALYTICAL	ADINAT
0.00	546.00	546.00
1.00	438.17	469.05
2.00	423.15	442.57
3.00	413.60	427.75
4.00	406.77	417.71
8.00	384.93	396.58
12.00	371.28	381.77
16.00	360.36	370.09
20.00	350.81	360.18
24.00	342.62	351.51
48.00	311.22	321.85
72.00	293.48	303.58
96.00	283.92	292.21

TIME STEPS:
4 AT 1 HRS.
5 AT 4 HRS.
3 AT 24 HRS.

ADINAT — PROBLEM 2.9 (RUN #1)

TEMPERATURE HISTORY AT X=L



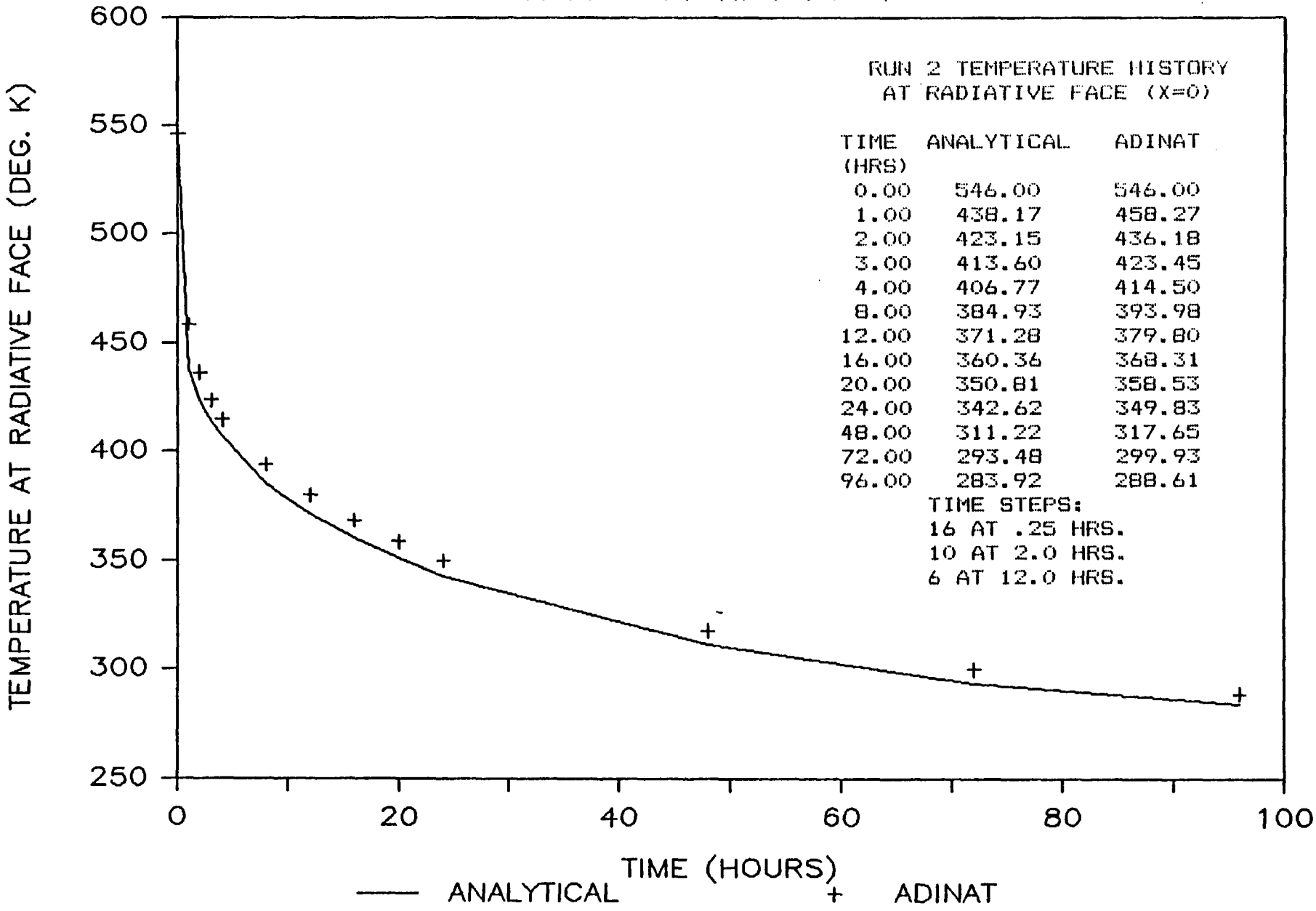
RUN 1 TEMPERATURE HISTORY
AT INSULATED FACE (X=L)

TIME (HRS)	ANALYTICAL	ADINAT
0.00	546.00	546.00
1.00	543.95	545.27
2.00	541.91	543.23
3.00	539.86	539.72
4.00	537.81	534.90
8.00	509.15	508.43
12.00	480.48	481.71
16.00	454.55	457.26
20.00	429.98	435.70
24.00	410.87	416.93
48.00	342.62	356.90
72.00	309.86	323.37
96.00	293.48	303.84

TIME STEPS:
4 AT 1 HRS.
5 AT 4 HRS.
3 AT 24 HRS.

ADINAT — PROBLEM 2.9 (RUN #2)

TEMPERATURE HISTORY AT X=0



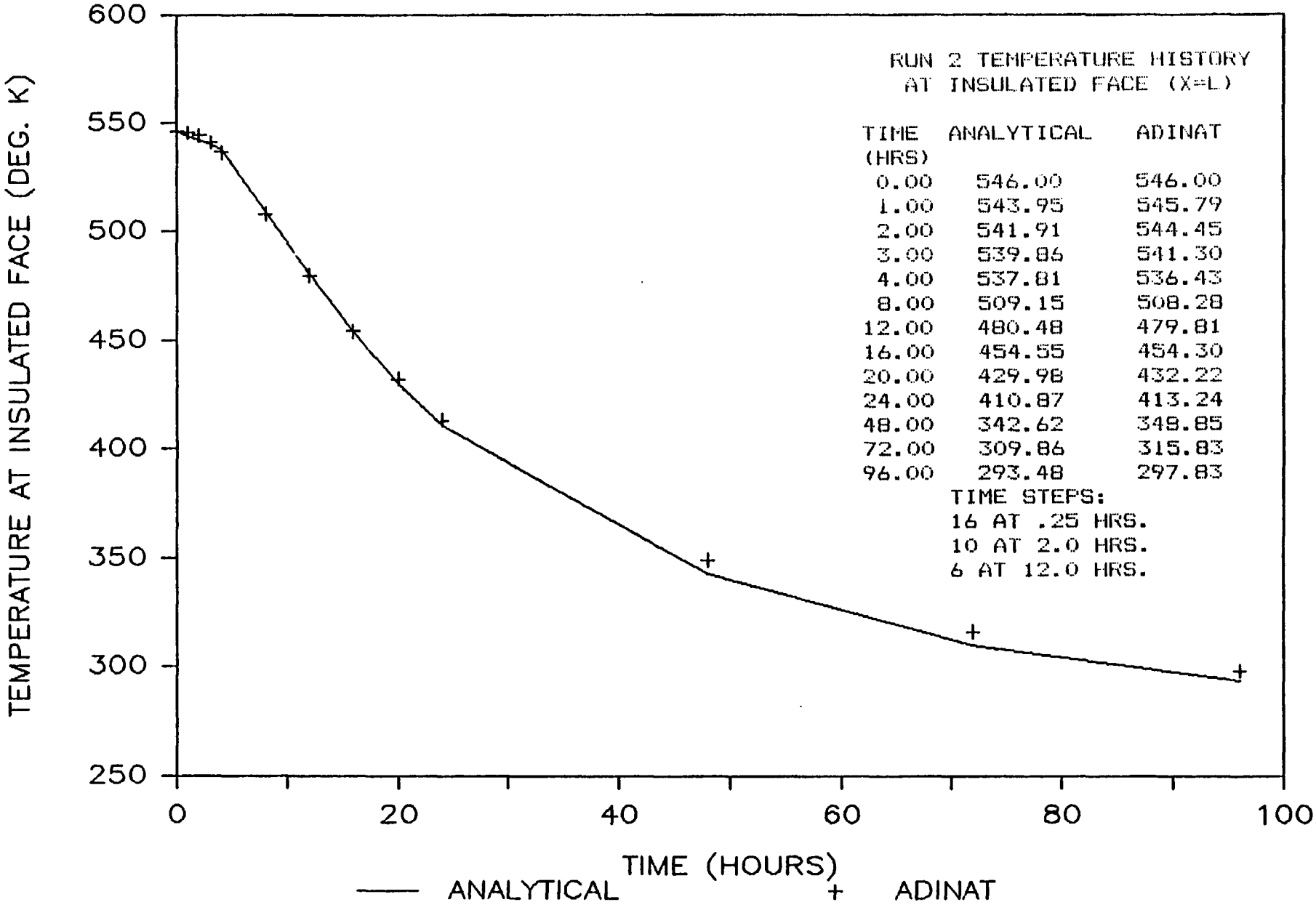
RUN 2 TEMPERATURE HISTORY
AT RADIATIVE FACE (X=0)

TIME (HRS)	ANALYTICAL	ADINAT
0.00	546.00	546.00
1.00	438.17	458.27
2.00	423.15	436.18
3.00	413.60	423.45
4.00	406.77	414.50
8.00	384.93	393.98
12.00	371.28	379.80
16.00	360.36	368.31
20.00	350.81	358.53
24.00	342.62	349.83
48.00	311.22	317.65
72.00	293.48	299.93
96.00	283.92	288.61

TIME STEPS:
16 AT .25 HRS.
10 AT 2.0 HRS.
6 AT 12.0 HRS.

ADINAT — PROBLEM 2.9 (RUN #2)

TEMPERATURE HISTORY AT X=L



RUN 2 TEMPERATURE HISTORY
AT INSULATED FACE (X=L)

TIME (HRS)	ANALYTICAL	ADINAT
0.00	546.00	546.00
1.00	543.95	545.79
2.00	541.91	544.45
3.00	539.86	541.30
4.00	537.81	536.43
8.00	509.15	508.28
12.00	480.48	479.81
16.00	454.55	454.30
20.00	429.98	432.22
24.00	410.87	413.24
48.00	342.62	348.85
72.00	309.86	315.83
96.00	293.48	297.83

TIME STEPS:
16 AT .25 HRS.
10 AT 2.0 HRS.
6 AT 12.0 HRS.

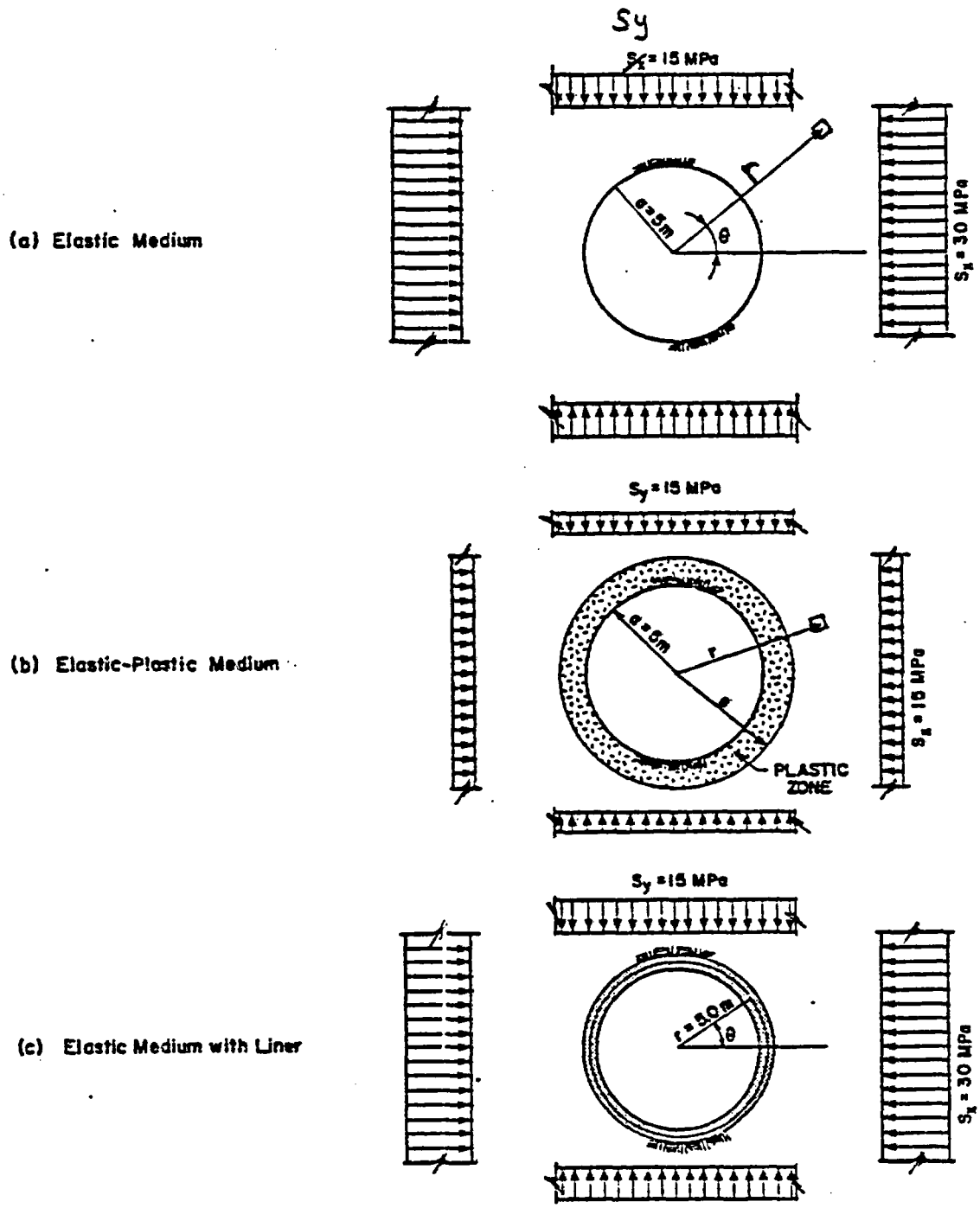
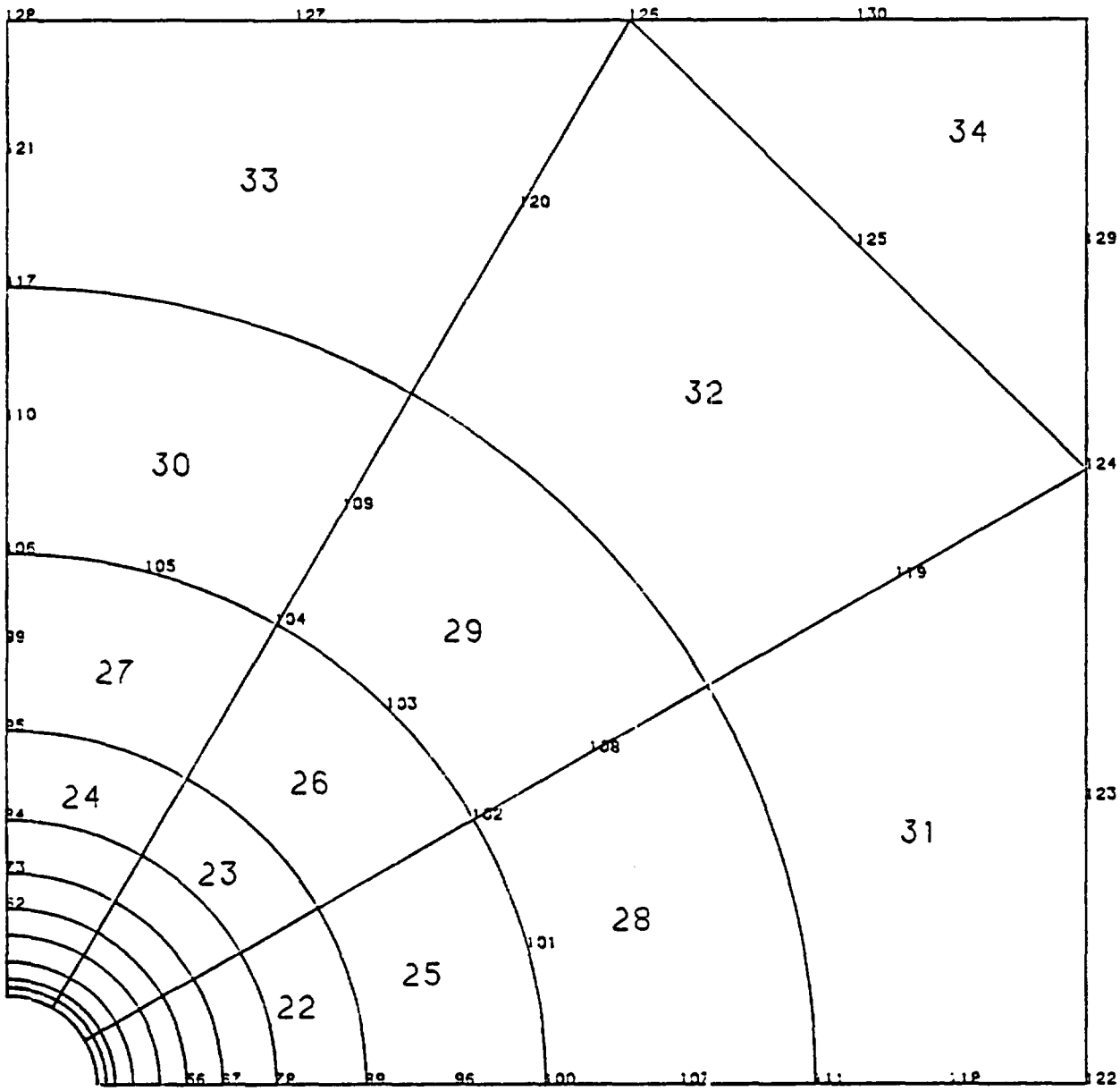
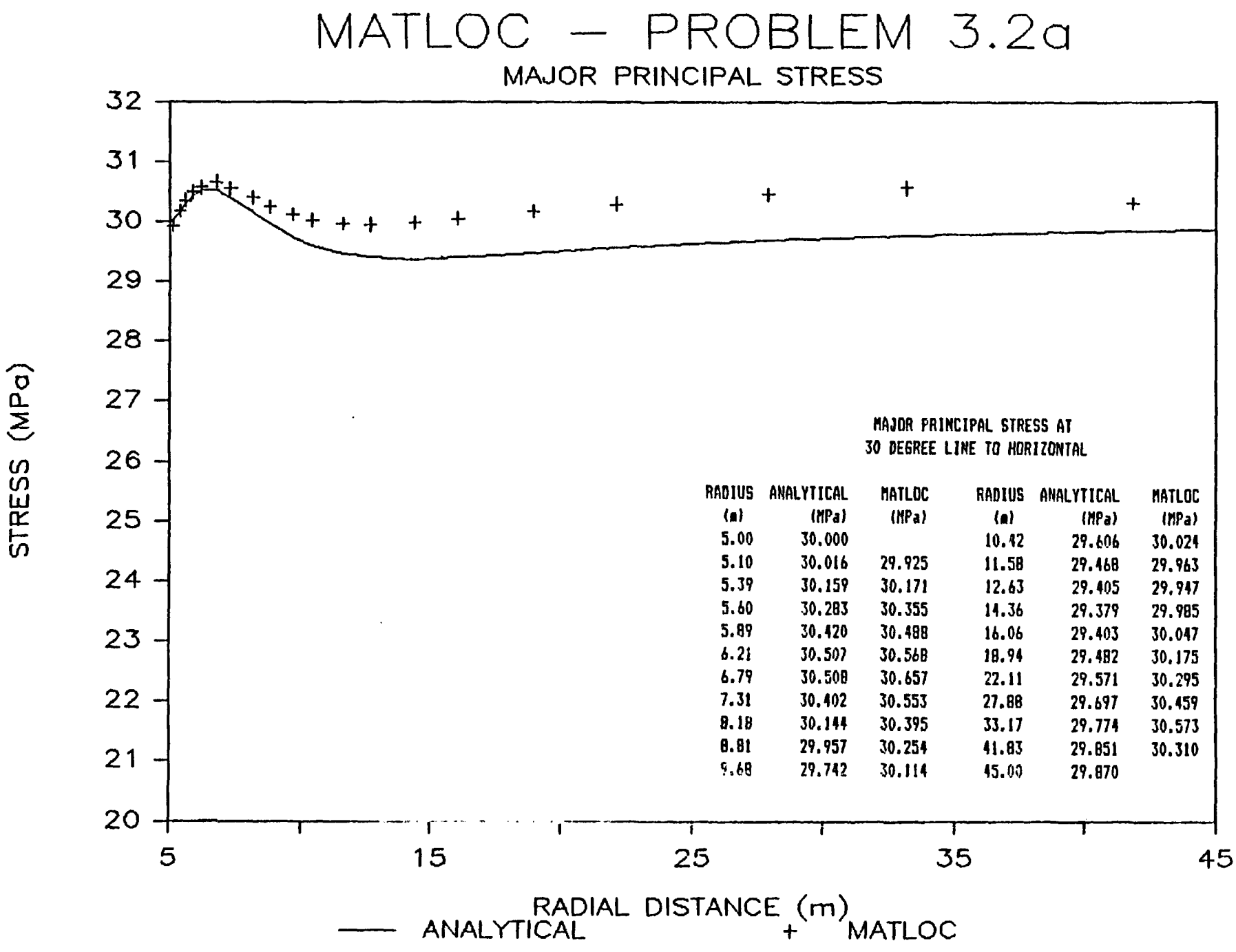


Figure 3.2-1 Circular Tunnel



4.0 m in X
4.0 m in Y

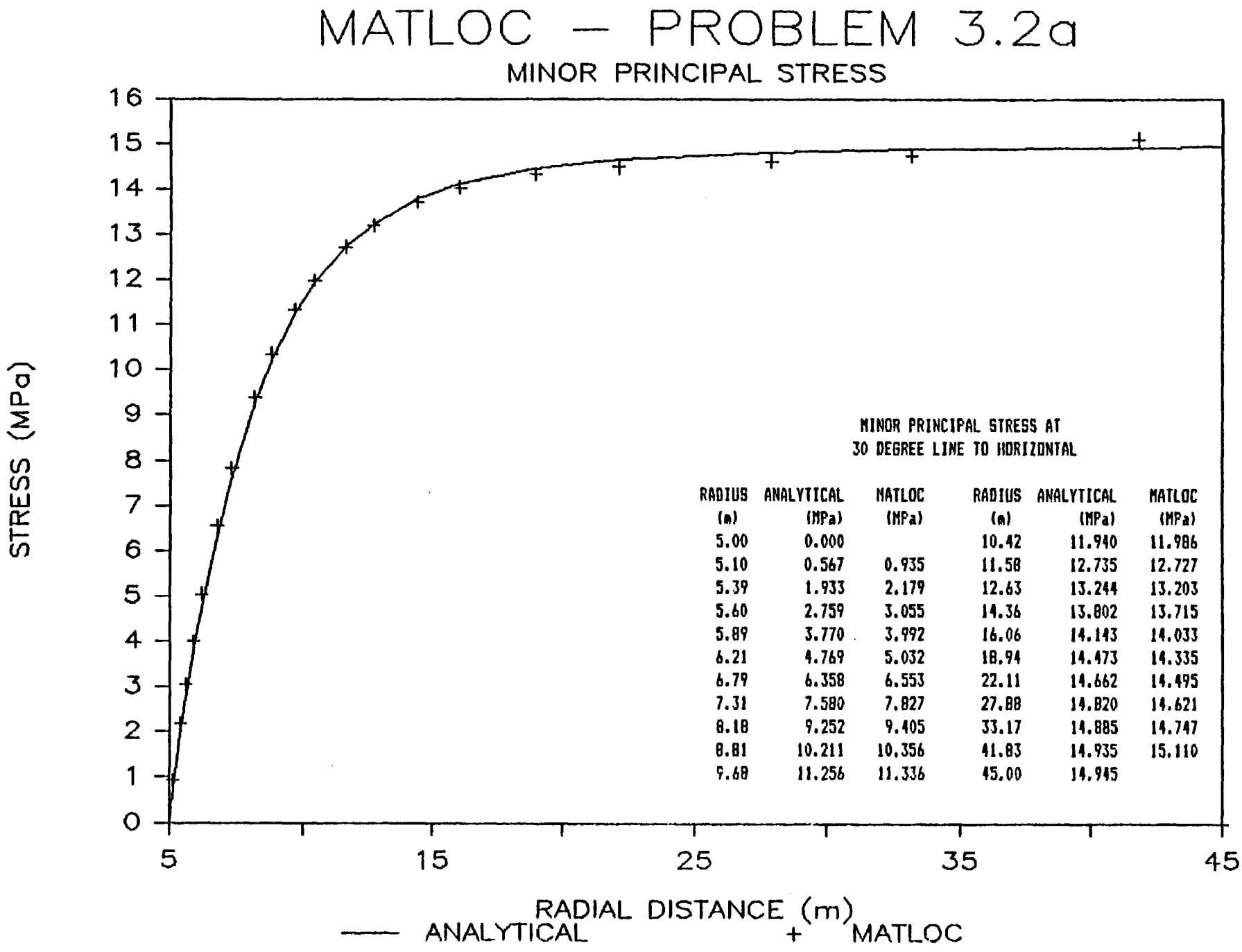
PROB 3.2a



MAJOR PRINCIPAL STRESS AT
30 DEGREE LINE TO HORIZONTAL

RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)	RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)
5.00	30.000		10.42	29.606	30.024
5.10	30.016	29.925	11.58	29.468	29.963
5.39	30.159	30.171	12.63	29.405	29.947
5.60	30.283	30.355	14.36	29.379	29.985
5.89	30.420	30.488	16.06	29.403	30.047
6.21	30.507	30.568	18.94	29.482	30.175
6.79	30.508	30.657	22.11	29.571	30.295
7.31	30.402	30.553	27.88	29.697	30.459
8.18	30.144	30.395	33.17	29.774	30.573
8.81	29.957	30.254	41.83	29.851	30.310
9.68	29.742	30.114	45.00	29.870	

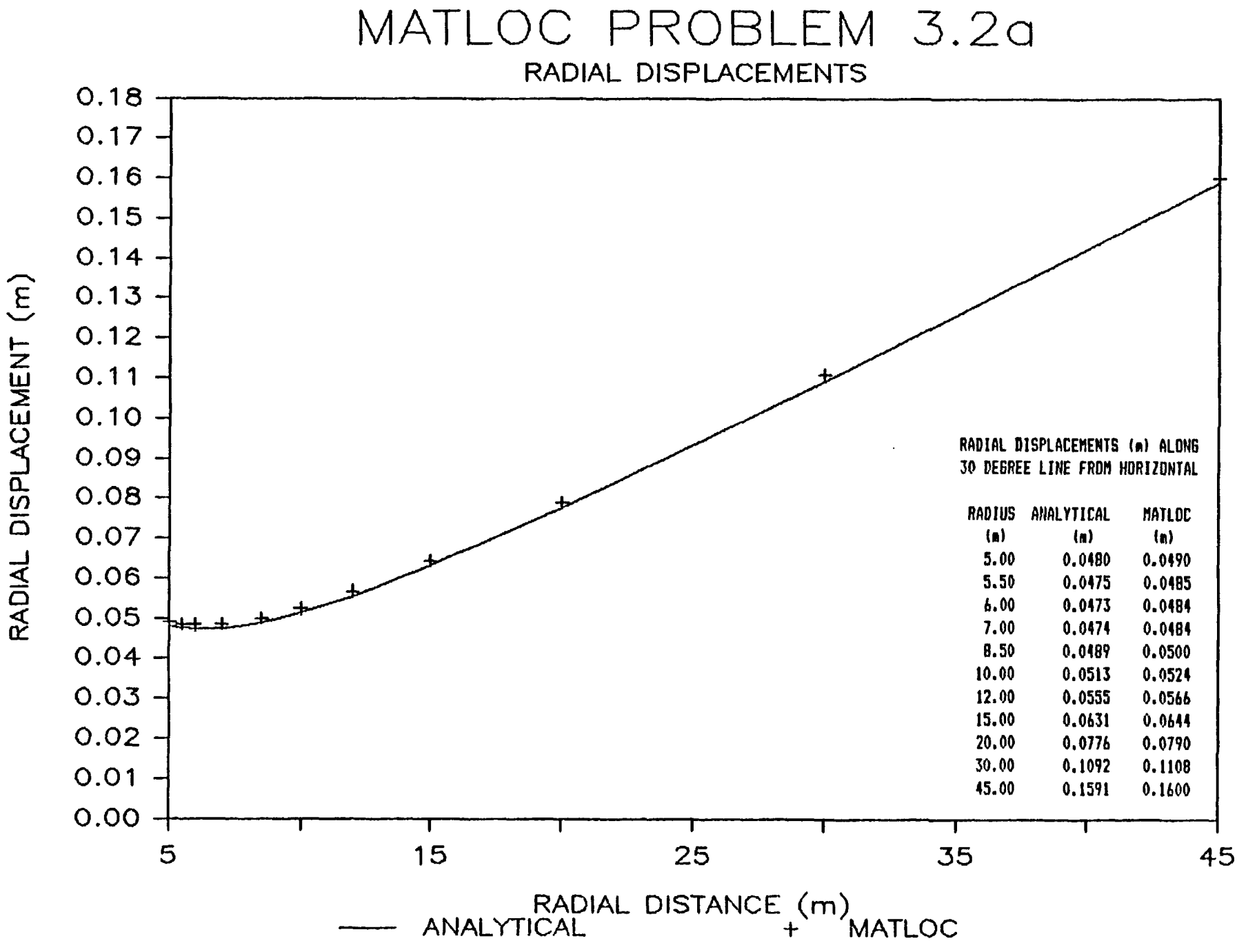
Figure 7.2-2 MATLOC Problem 3.2a
Major Principal Stresses along a
Line 30 Degrees from Horizontal



MINOR PRINCIPAL STRESS AT
30 DEGREE LINE TO HORIZONTAL

RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)	RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)
5.00	0.000		10.42	11.940	11.986
5.10	0.567	0.935	11.58	12.735	12.727
5.39	1.933	2.179	12.63	13.244	13.203
5.60	2.759	3.055	14.36	13.802	13.715
5.89	3.770	3.992	16.06	14.143	14.033
6.21	4.769	5.032	18.94	14.473	14.335
6.79	6.358	6.553	22.11	14.662	14.495
7.31	7.580	7.827	27.88	14.820	14.621
8.18	9.252	9.405	33.17	14.885	14.747
8.81	10.211	10.356	41.83	14.935	15.110
9.68	11.256	11.336	45.00	14.945	

Figure 7.2-3 MATLOC Problem 3.2a
Minor Principal Stresses along a
Line 30 Degrees from Horizontal



RADIAL DISPLACEMENTS (m) ALONG 30 DEGREE LINE FROM HORIZONTAL

RADIUS (m)	ANALYTICAL (m)	MATLOC (m)
5.00	0.0480	0.0490
5.50	0.0475	0.0485
6.00	0.0473	0.0484
7.00	0.0474	0.0484
8.50	0.0489	0.0500
10.00	0.0513	0.0524
12.00	0.0555	0.0566
15.00	0.0631	0.0644
20.00	0.0776	0.0790
30.00	0.1092	0.1108
45.00	0.1591	0.1600

Figure 7.2-5 MATLOC Problem 3.2a
Radial Displacements along a line
30 Degrees from Horizontal

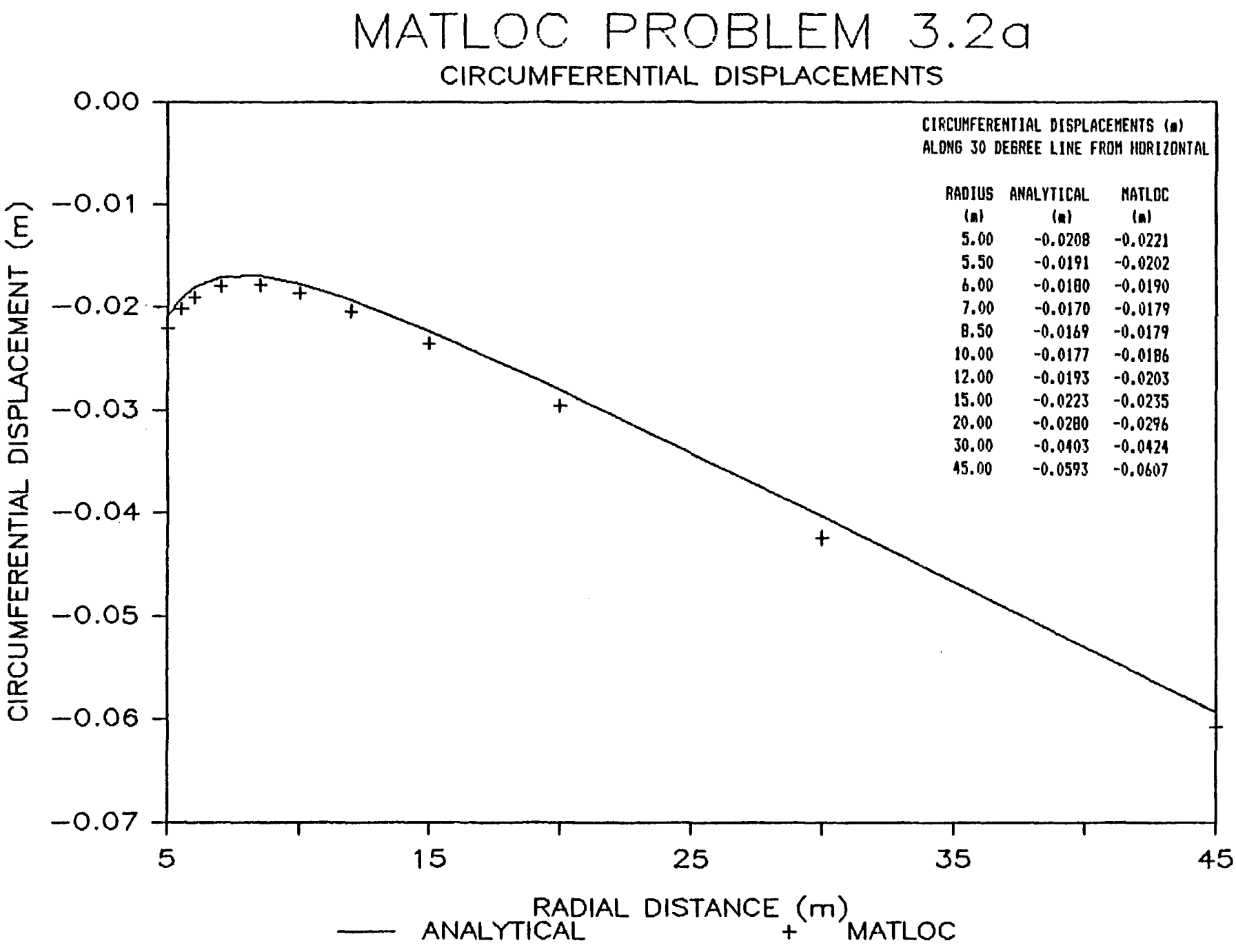
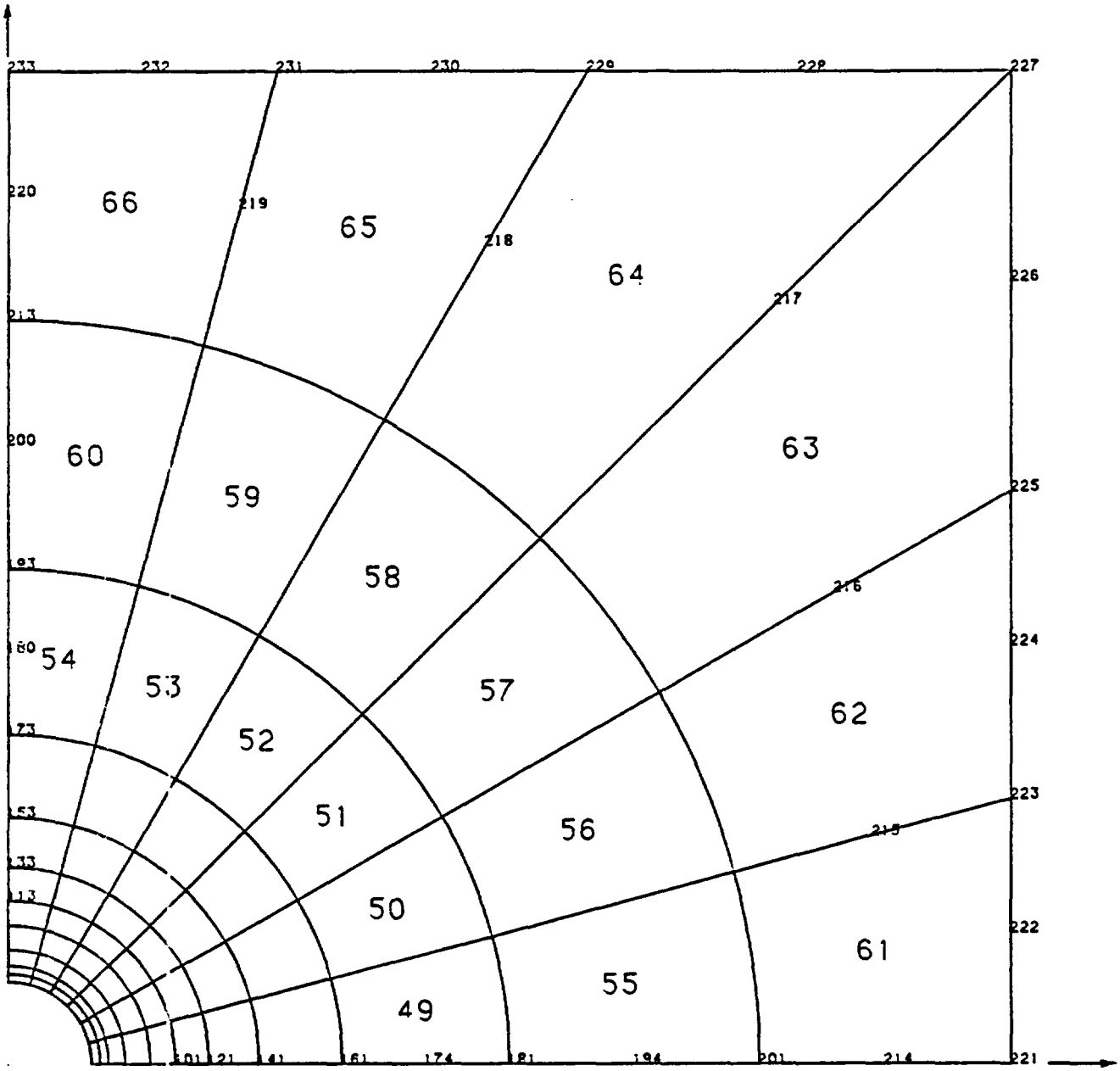


Figure 7.2-6 MATLOC Problem 3.2a
Circumferential Displacements along a
Line 30 Degrees from Horizontal


233
232
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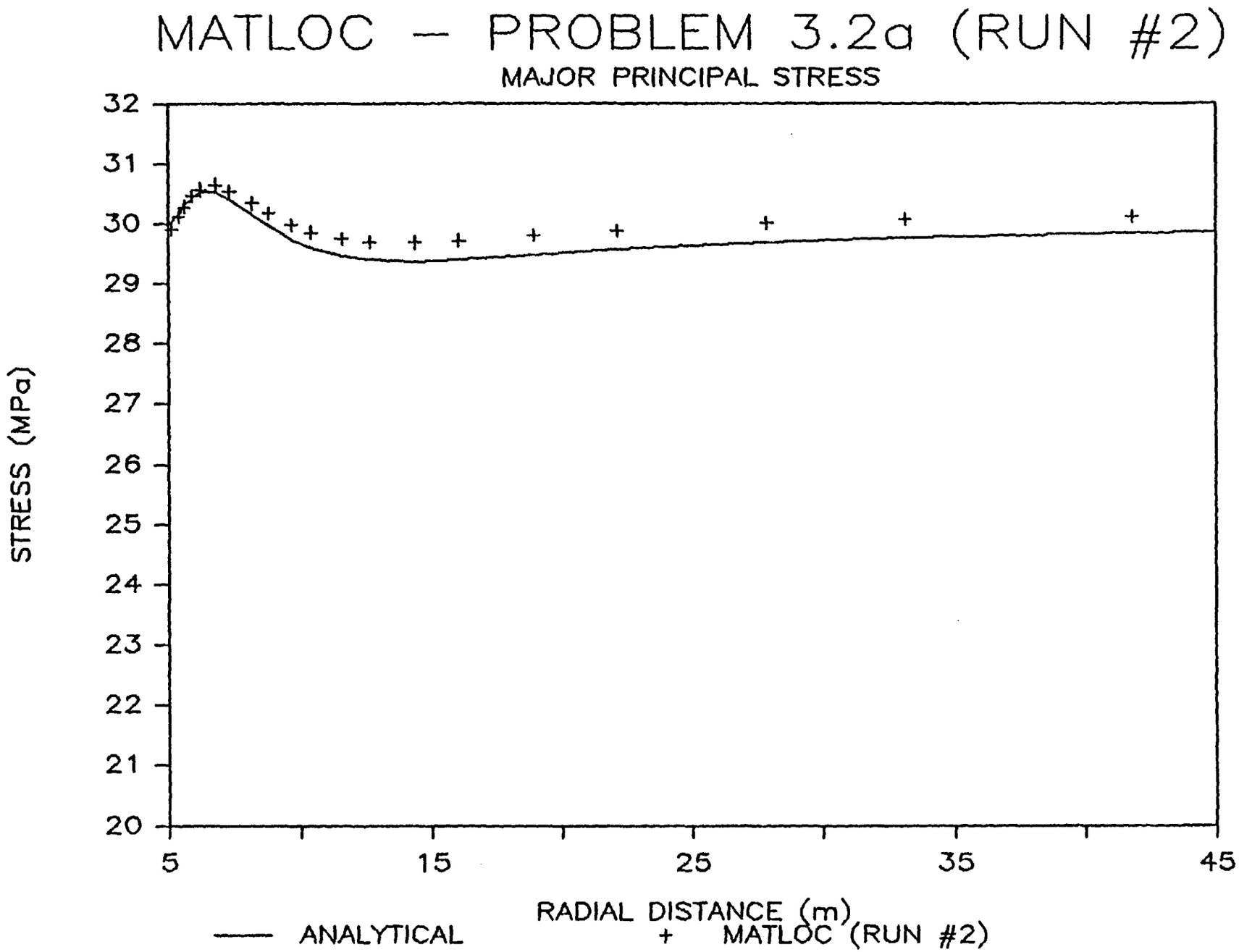
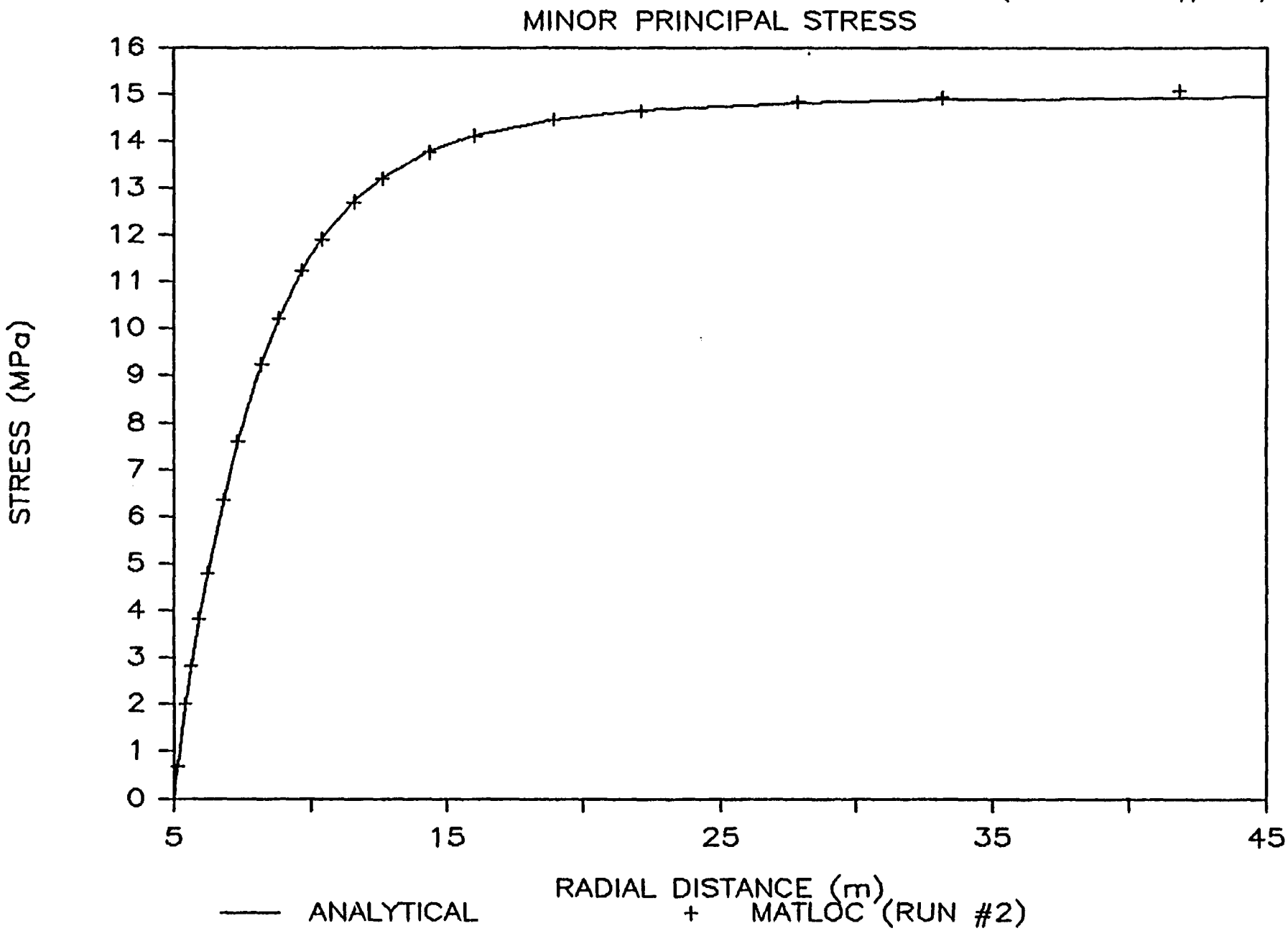
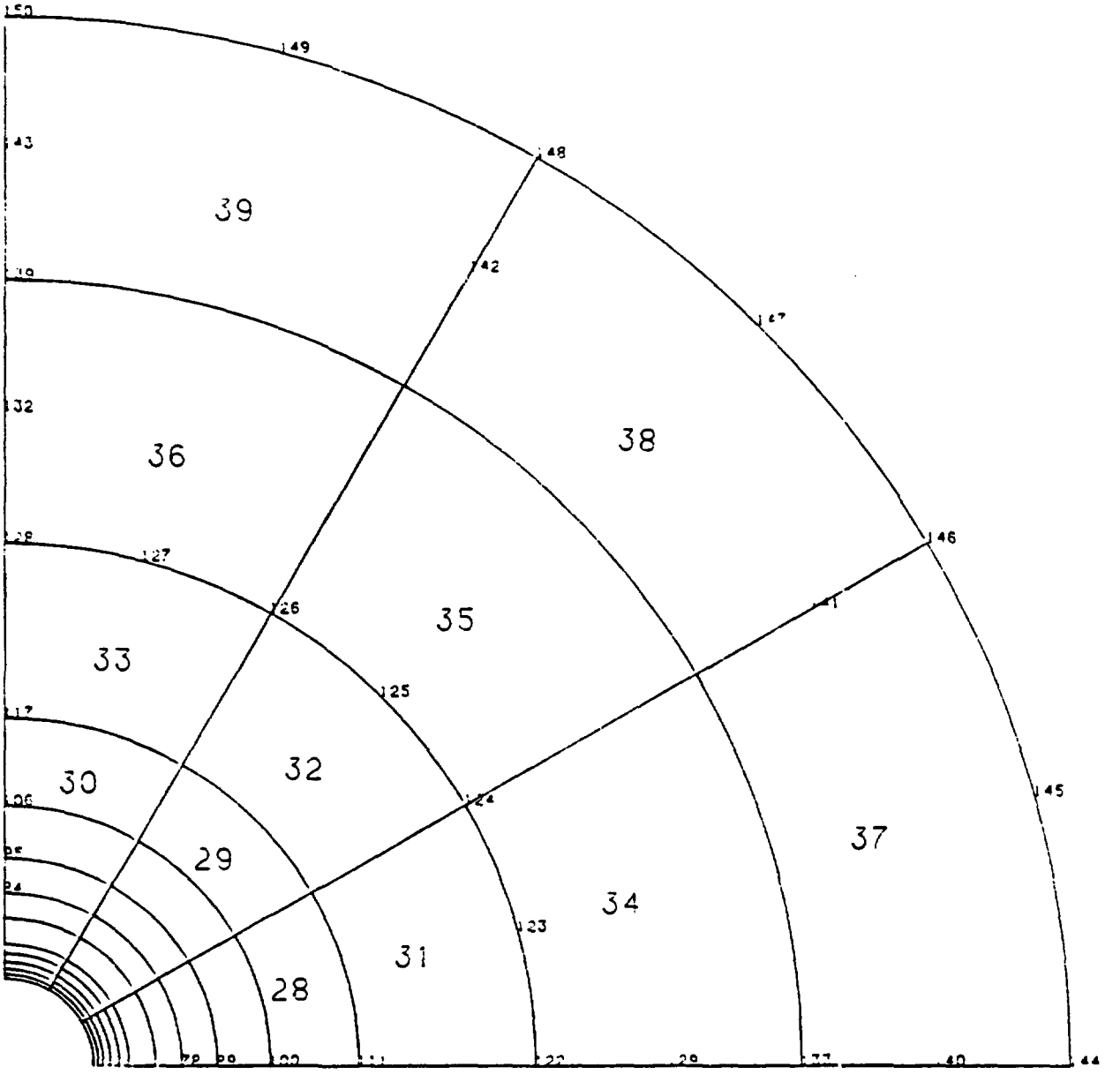
193
216
180
224
173
223
153
215
133
113
222
221
101
121
141
161
174
181
194
201
214
66
65
64
63
60
59
58
54
53
52
57
62
51
56
50
61
55
49
4.0 m in X
4.0 m in Y


MATLOC – PROBLEM 3.2a (RUN #2)
MAJOR PRINCIPAL STRESS
STRESS (MPa)
32
31
30
29
28
27
26
25
24
23
22
21
20
5
15
25
35
45
RADIAL DISTANCE (m)
ANALYTICAL
+ MATLOC (RUN #2)

MATLOC – PROBLEM 3.2a (RUN #2)



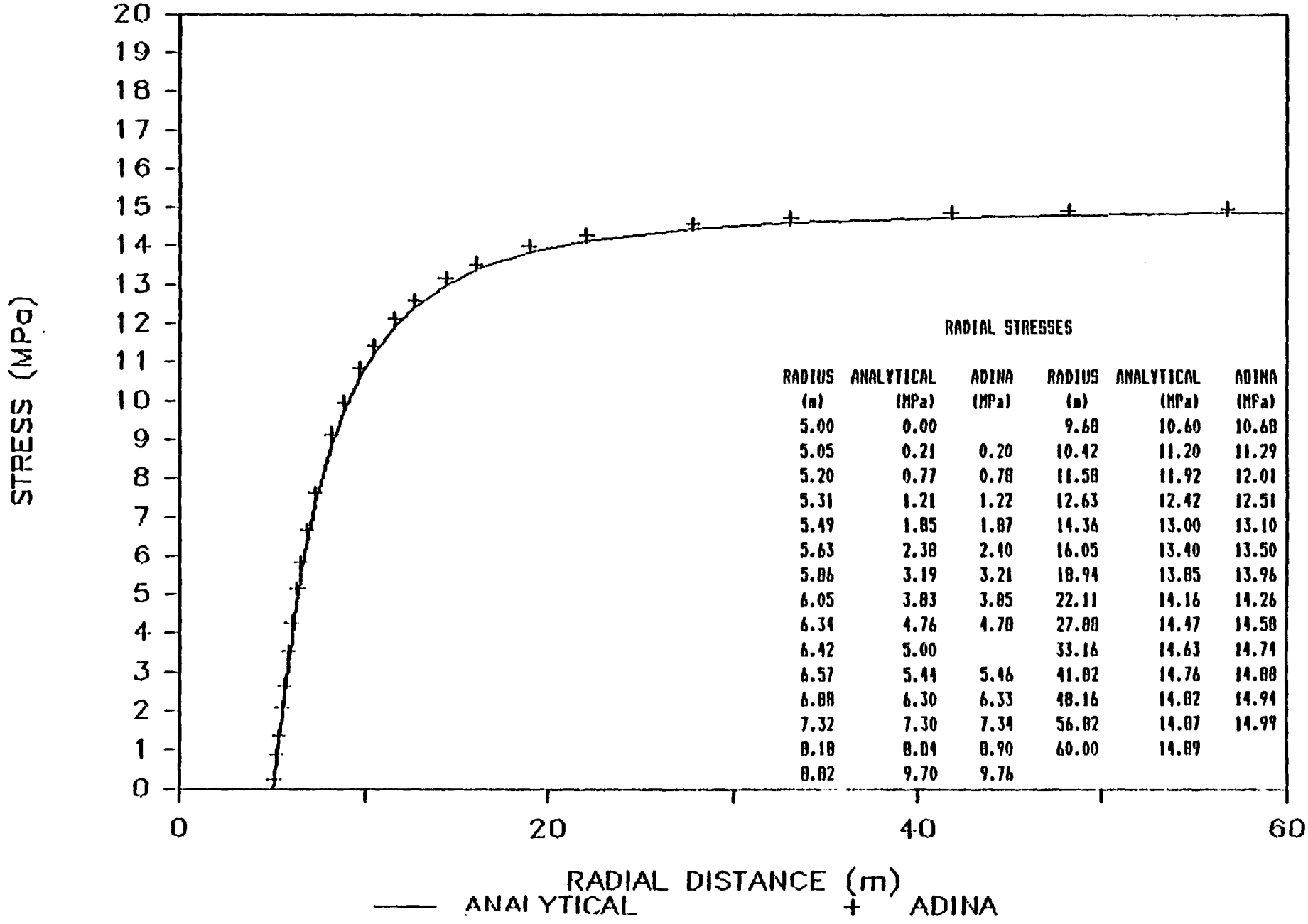


4.0 m in X
4.0 m in Y

PROB 3.2b

ADINA — PROBLEM 3.2b

RADIAL STRESS



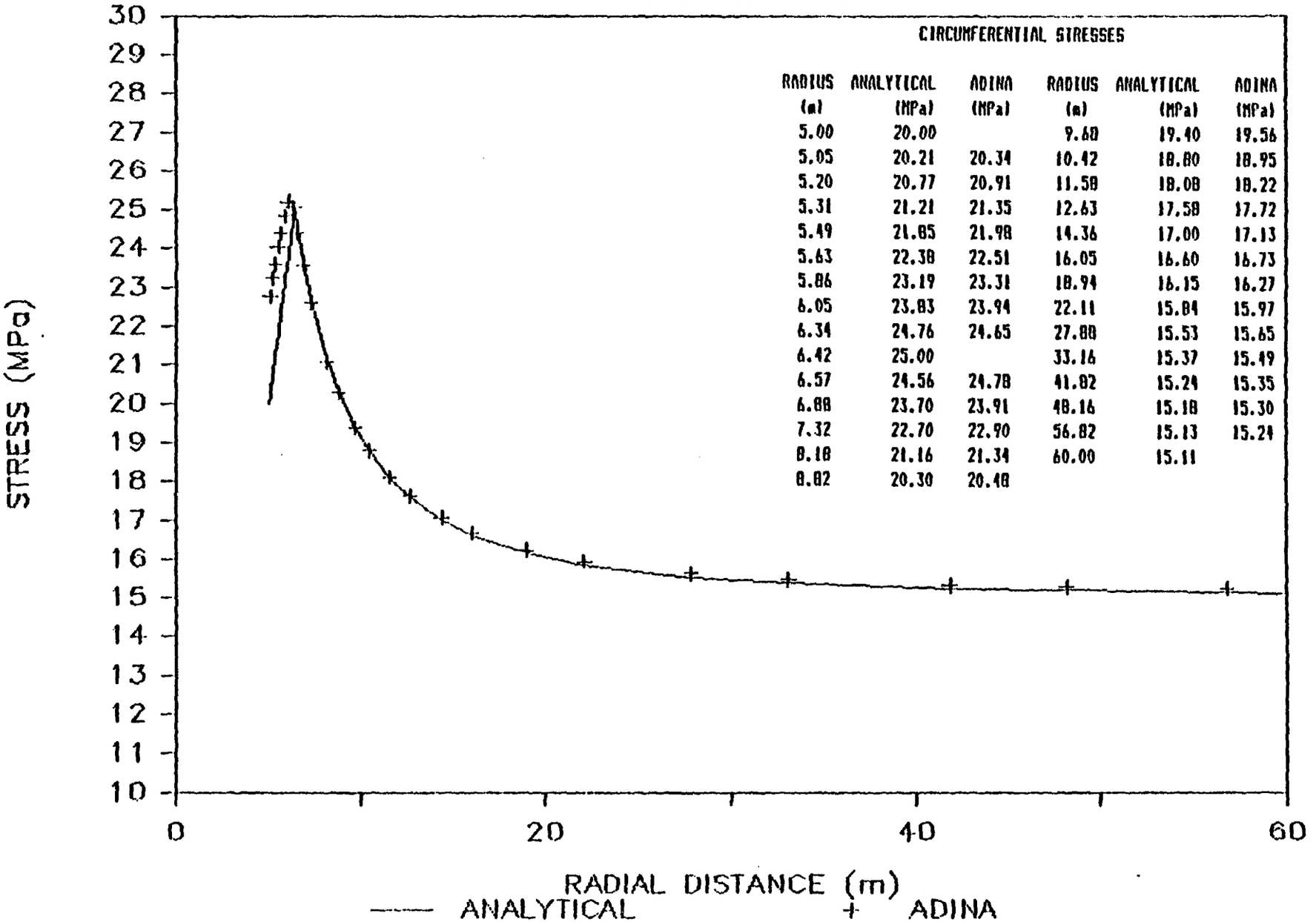
RADIAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	ADINA (MPa)	RADIUS (m)	ANALYTICAL (MPa)	ADINA (MPa)
5.00	0.00		9.68	10.60	10.68
5.05	0.21	0.20	10.42	11.20	11.29
5.20	0.77	0.78	11.58	11.92	12.01
5.31	1.21	1.22	12.63	12.42	12.51
5.49	1.85	1.87	14.36	13.00	13.10
5.63	2.38	2.40	16.05	13.40	13.50
5.86	3.19	3.21	18.94	13.85	13.96
6.05	3.83	3.85	22.11	14.16	14.26
6.34	4.76	4.78	27.88	14.47	14.58
6.42	5.00		33.16	14.63	14.74
6.57	5.44	5.46	41.82	14.76	14.88
6.88	6.30	6.33	48.16	14.82	14.94
7.32	7.30	7.34	56.82	14.87	14.99
8.18	8.04	8.90	60.00	14.89	
8.82	9.70	9.76			

ADINA Problem 3.2b
RADIAL STRESS COMPARISON

ADINA — PROBLEM 3.2b

CIRCUMFERENTIAL STRESS



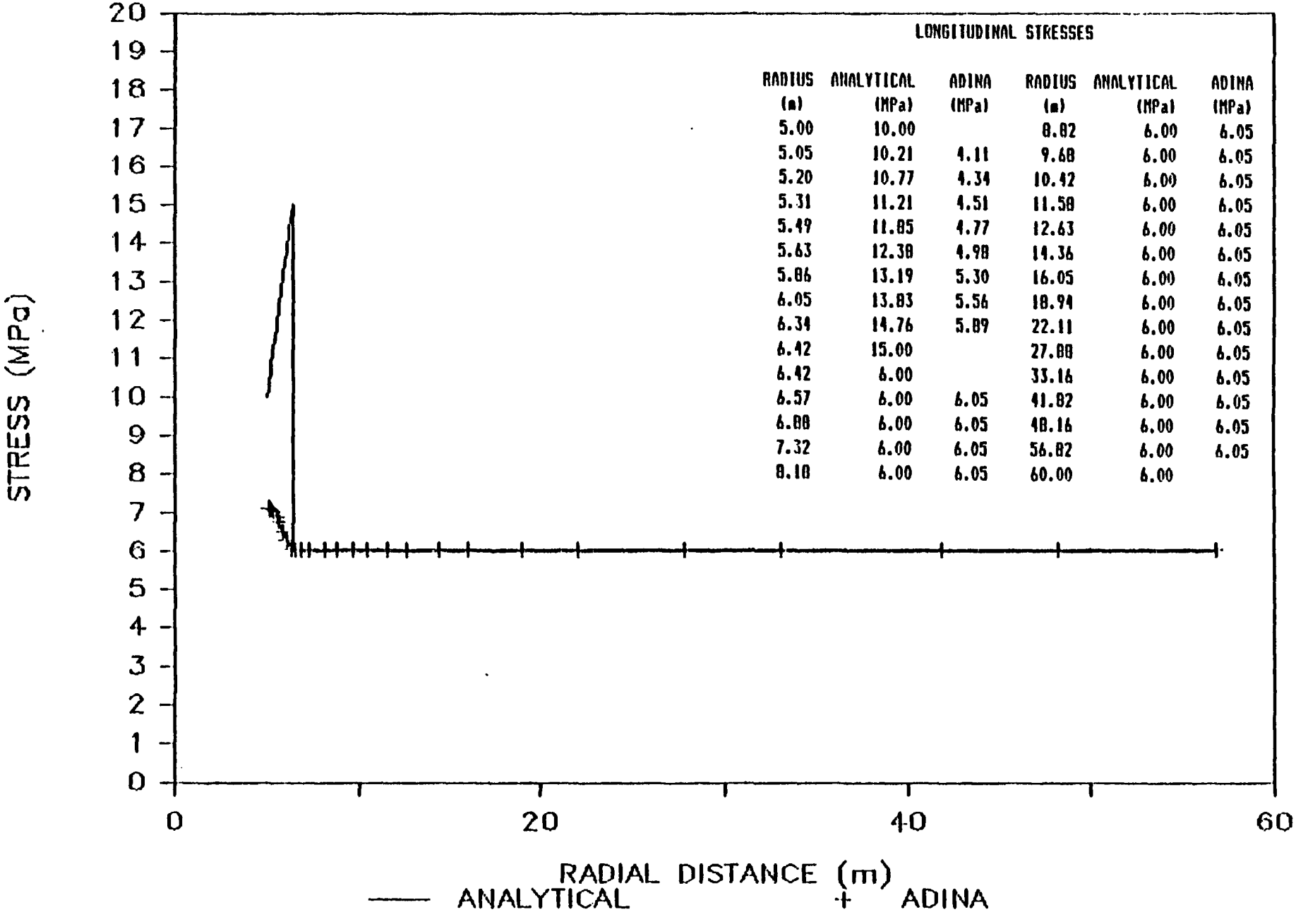
CIRCUMFERENTIAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	ADINA (MPa)	RADIUS (m)	ANALYTICAL (MPa)	ADINA (MPa)
5.00	20.00		9.60	19.40	19.56
5.05	20.21	20.34	10.42	18.80	18.95
5.20	20.77	20.91	11.58	18.08	18.22
5.31	21.21	21.35	12.63	17.58	17.72
5.49	21.85	21.98	14.36	17.00	17.13
5.63	22.38	22.51	16.05	16.60	16.73
5.86	23.19	23.31	18.94	16.15	16.27
6.05	23.83	23.94	22.11	15.84	15.97
6.34	24.76	24.65	27.88	15.53	15.65
6.42	25.00		33.16	15.37	15.49
6.57	24.56	24.78	41.82	15.24	15.35
6.88	23.70	23.91	48.16	15.18	15.30
7.32	22.70	22.90	56.82	15.13	15.24
8.18	21.16	21.34	60.00	15.11	
8.82	20.30	20.48			

ADINA Problem 3.2b
CIRCUMFERENTIAL STRESS COMPARISON

ADINA — PROBLEM 3.2b

LONGITUDINAL STRESS



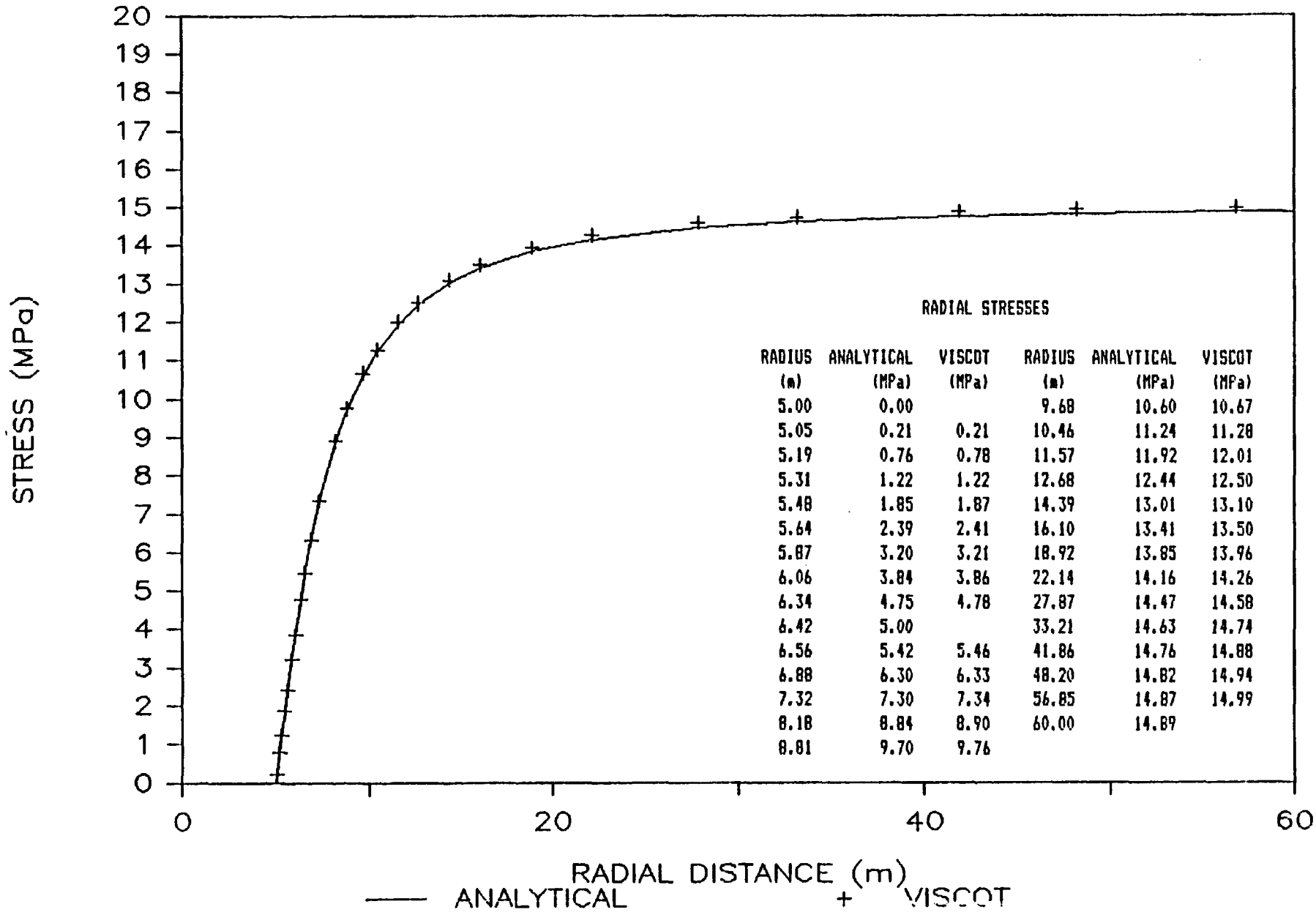
LONGITUDINAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	ADINA (MPa)	RADIUS (m)	ANALYTICAL (MPa)	ADINA (MPa)
5.00	10.00		8.82	6.00	6.05
5.05	10.21	4.11	9.68	6.00	6.05
5.20	10.77	4.34	10.42	6.00	6.05
5.31	11.21	4.51	11.58	6.00	6.05
5.49	11.85	4.77	12.63	6.00	6.05
5.63	12.38	4.98	14.36	6.00	6.05
5.86	13.19	5.30	16.05	6.00	6.05
6.05	13.83	5.56	18.94	6.00	6.05
6.34	14.76	5.89	22.11	6.00	6.05
6.42	15.00		27.88	6.00	6.05
6.42	6.00		33.16	6.00	6.05
6.57	6.00	6.05	41.82	6.00	6.05
6.88	6.00	6.05	48.16	6.00	6.05
7.32	6.00	6.05	56.82	6.00	6.05
8.18	6.00	6.05	60.00	6.00	

ADINA Problem 3.2b
LONGITUDINAL STRESS COMPARISON

VISCOT -- PROBLEM 3.2b

RADIAL STRESS

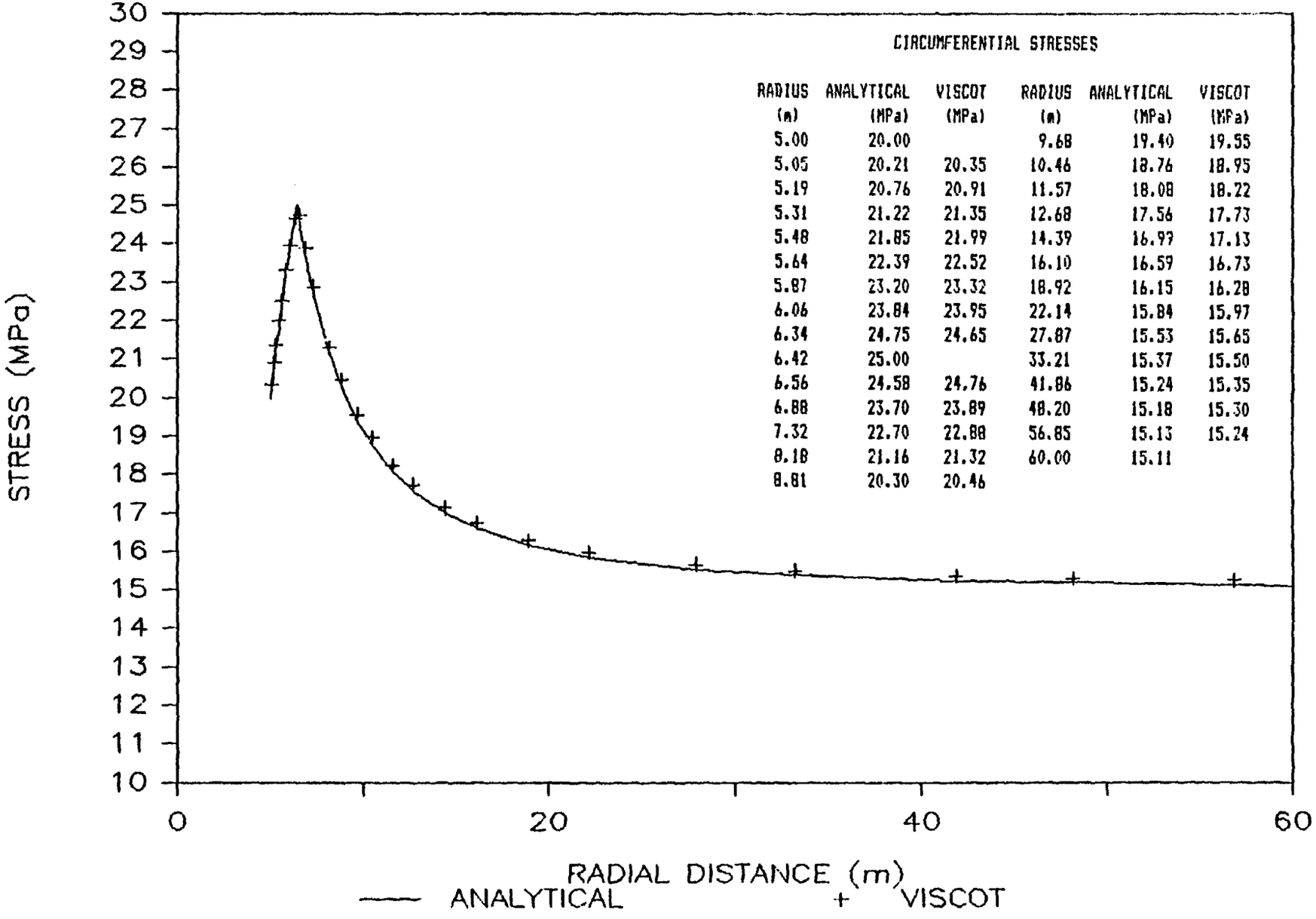


RADIAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)	RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)
5.00	0.00		9.68	10.60	10.67
5.05	0.21	0.21	10.46	11.24	11.28
5.19	0.76	0.78	11.57	11.92	12.01
5.31	1.22	1.22	12.68	12.44	12.50
5.48	1.85	1.87	14.39	13.01	13.10
5.64	2.39	2.41	16.10	13.41	13.50
5.87	3.20	3.21	18.92	13.85	13.96
6.06	3.84	3.86	22.14	14.16	14.26
6.34	4.75	4.78	27.87	14.47	14.58
6.42	5.00		33.21	14.63	14.74
6.56	5.42	5.46	41.86	14.76	14.88
6.88	6.30	6.33	48.20	14.82	14.94
7.32	7.30	7.34	56.85	14.87	14.99
8.18	8.84	8.90	60.00	14.89	
8.81	9.70	9.76			

VISCOT – PROBLEM 3.2b

CIRCUMFERENTIAL STRESS

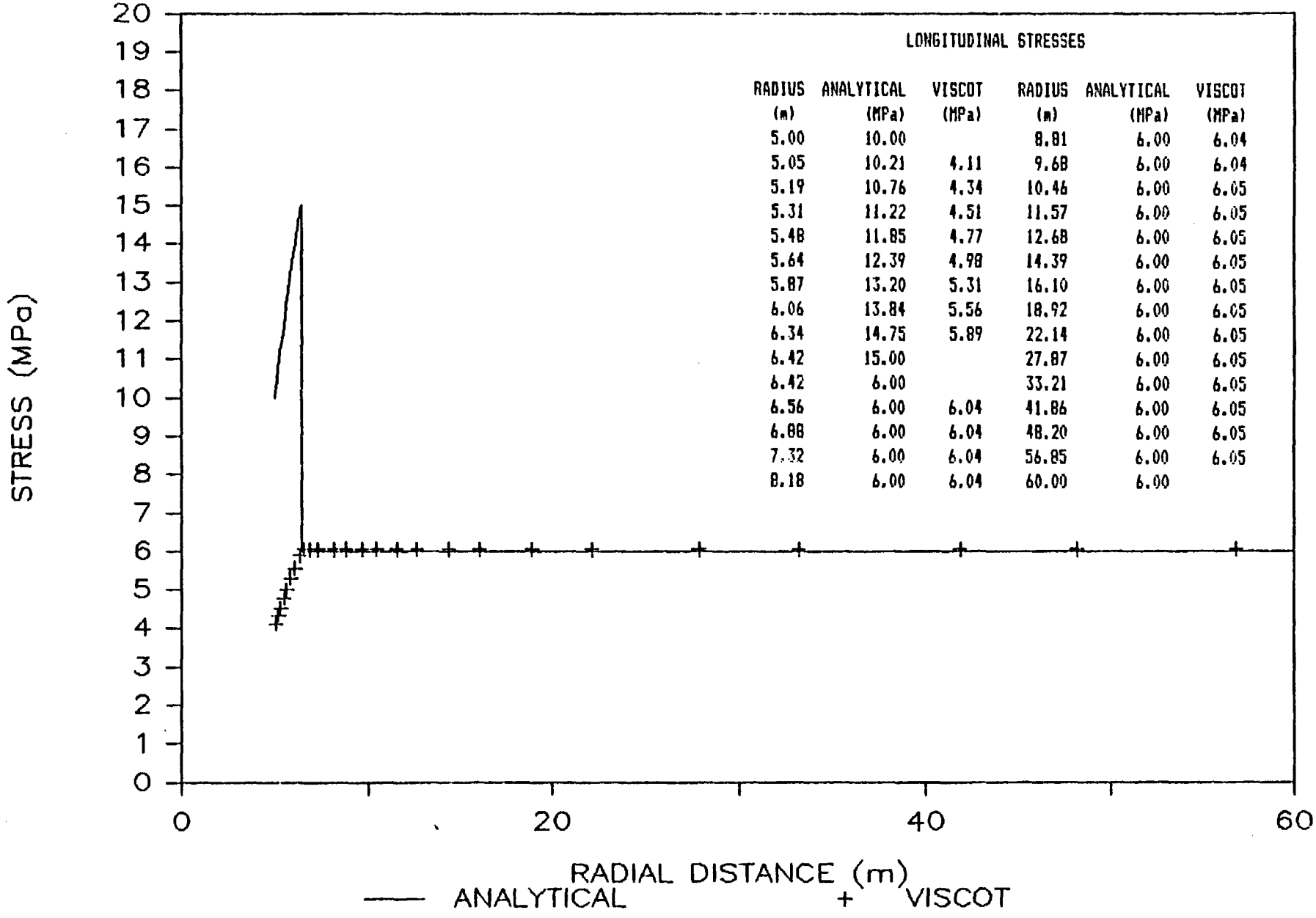


CIRCUMFERENTIAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)	RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)
5.00	20.00		9.68	19.40	19.55
5.05	20.21	20.35	10.46	18.76	18.95
5.19	20.76	20.91	11.57	18.08	18.22
5.31	21.22	21.35	12.68	17.56	17.73
5.48	21.85	21.99	14.39	16.99	17.13
5.64	22.39	22.52	16.10	16.59	16.73
5.87	23.20	23.32	18.92	16.15	16.28
6.06	23.84	23.95	22.14	15.84	15.97
6.34	24.75	24.65	27.87	15.53	15.65
6.42	25.00		33.21	15.37	15.50
6.56	24.58	24.76	41.86	15.24	15.35
6.88	23.70	23.89	48.20	15.18	15.30
7.32	22.70	22.88	56.85	15.13	15.24
8.18	21.16	21.32	60.00	15.11	
8.81	20.30	20.46			

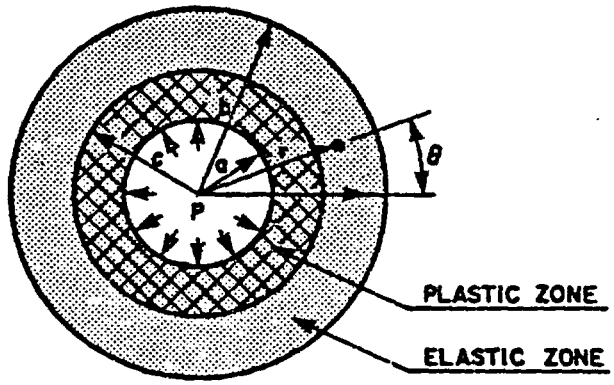
VISCOT — PROBLEM 3.2b

LONGITUDINAL STRESS

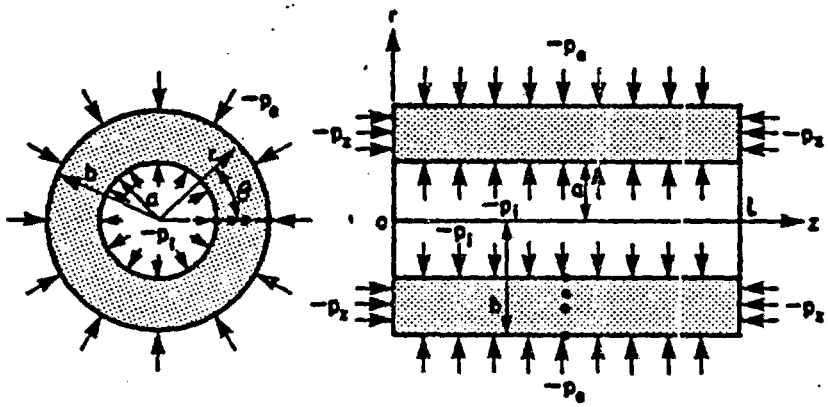


LONGITUDINAL STRESSES

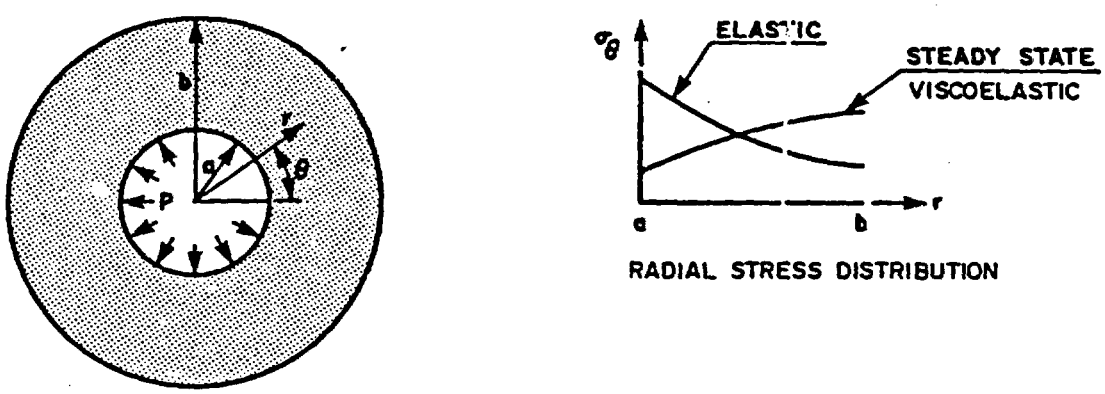
RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)	RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)
5.00	10.00		8.81	6.00	6.04
5.05	10.21	4.11	9.68	6.00	6.04
5.19	10.76	4.34	10.46	6.00	6.05
5.31	11.22	4.51	11.57	6.00	6.05
5.48	11.85	4.77	12.68	6.00	6.05
5.64	12.39	4.98	14.39	6.00	6.05
5.87	13.20	5.31	16.10	6.00	6.05
6.06	13.84	5.56	18.92	6.00	6.05
6.34	14.75	5.89	22.14	6.00	6.05
6.42	15.00		27.87	6.00	6.05
6.42	6.00		33.21	6.00	6.05
6.56	6.00	6.04	41.86	6.00	6.05
6.88	6.00	6.04	48.20	6.00	6.05
7.32	6.00	6.04	56.85	6.00	6.05
8.18	6.00	6.04	60.00	6.00	



(a) ELASTIC-PLASTIC ANALYSIS

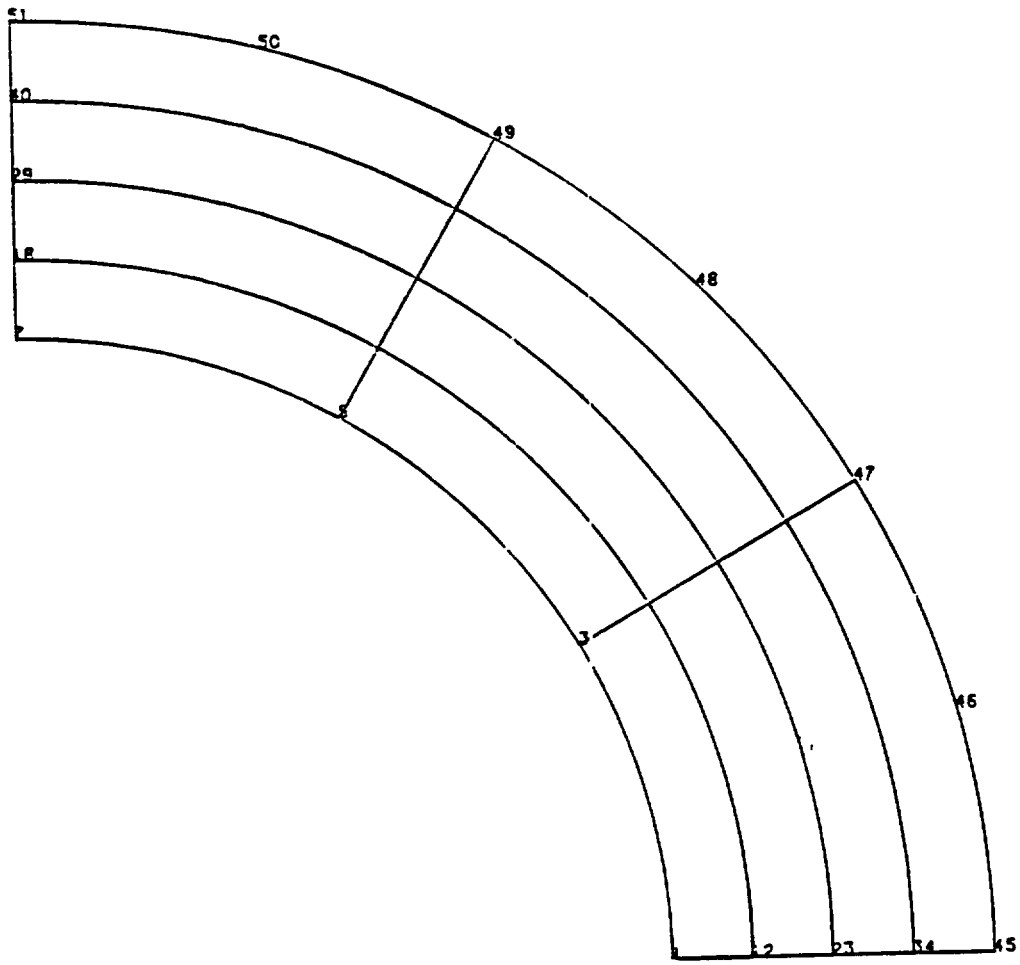


(b) ELASTIC ANALYSIS



(c) VISCOELASTIC ANALYSIS

Figure 3.3-1 Thick-walled Cylinder Subjected to Internal and/or External Pressure

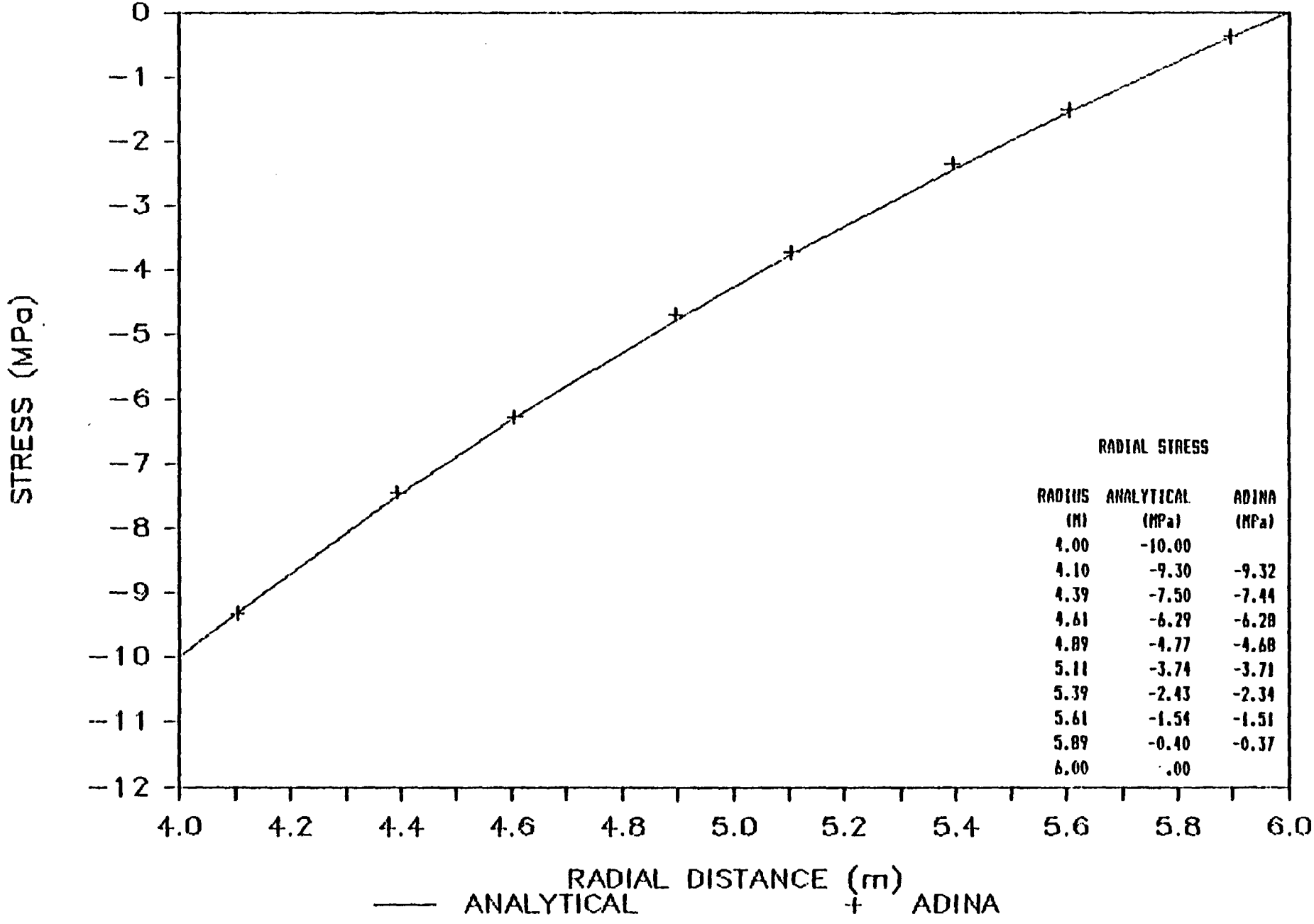


0.5 m in X
0.5 m in Y

PROB 3.3c

ADINA — PROBLEM 3.3c

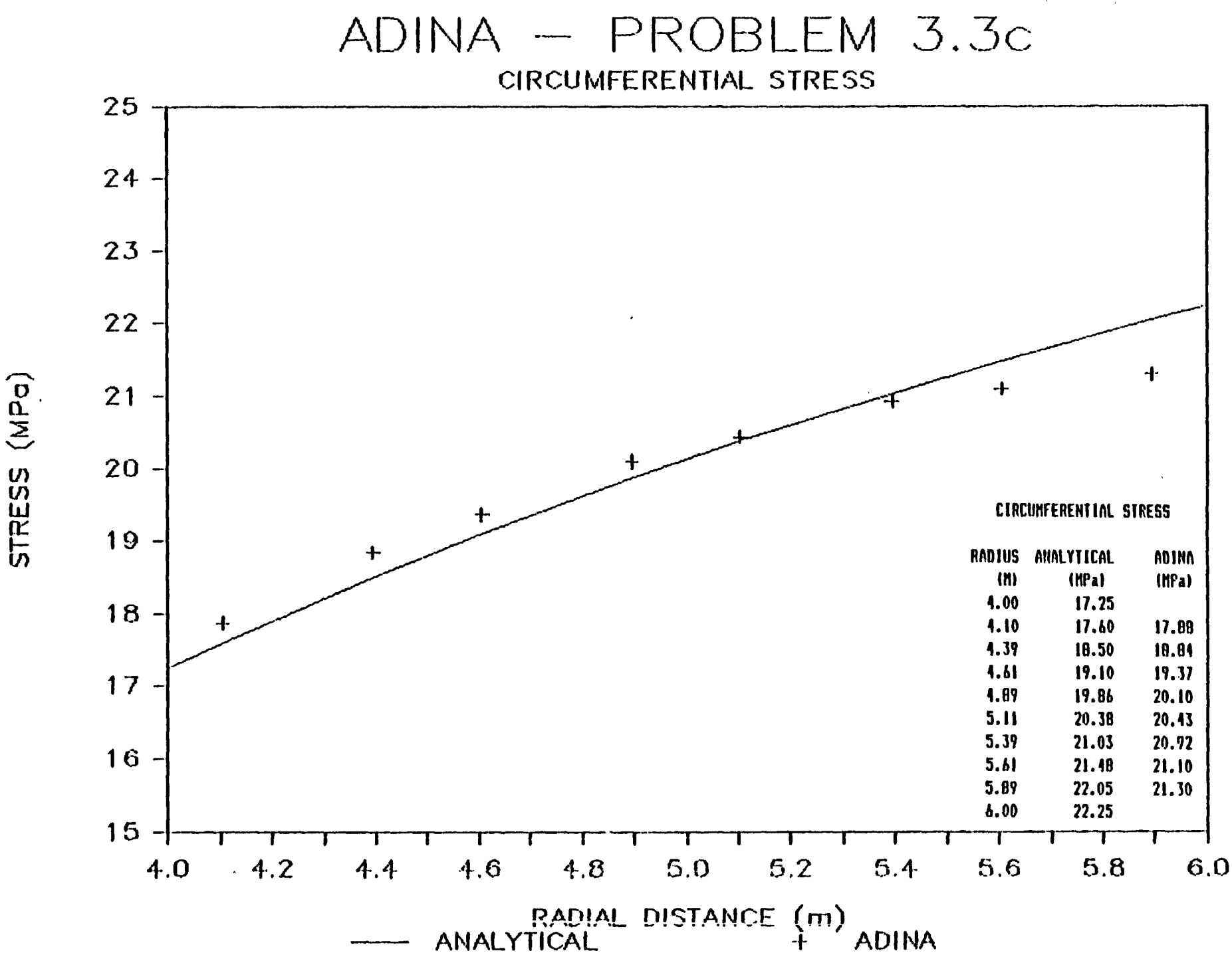
RADIAL STRESS



RADIAL STRESS

RADIUS (M)	ANALYTICAL (MPa)	ADINA (MPa)
4.00	-10.00	
4.10	-9.30	-9.32
4.39	-7.50	-7.44
4.61	-6.29	-6.28
4.89	-4.77	-4.68
5.11	-3.74	-3.71
5.39	-2.43	-2.34
5.61	-1.54	-1.51
5.89	-0.40	-0.37
6.00	.00	

ADINA Problem 3.3c
RADIAL STRESS COMPARISON



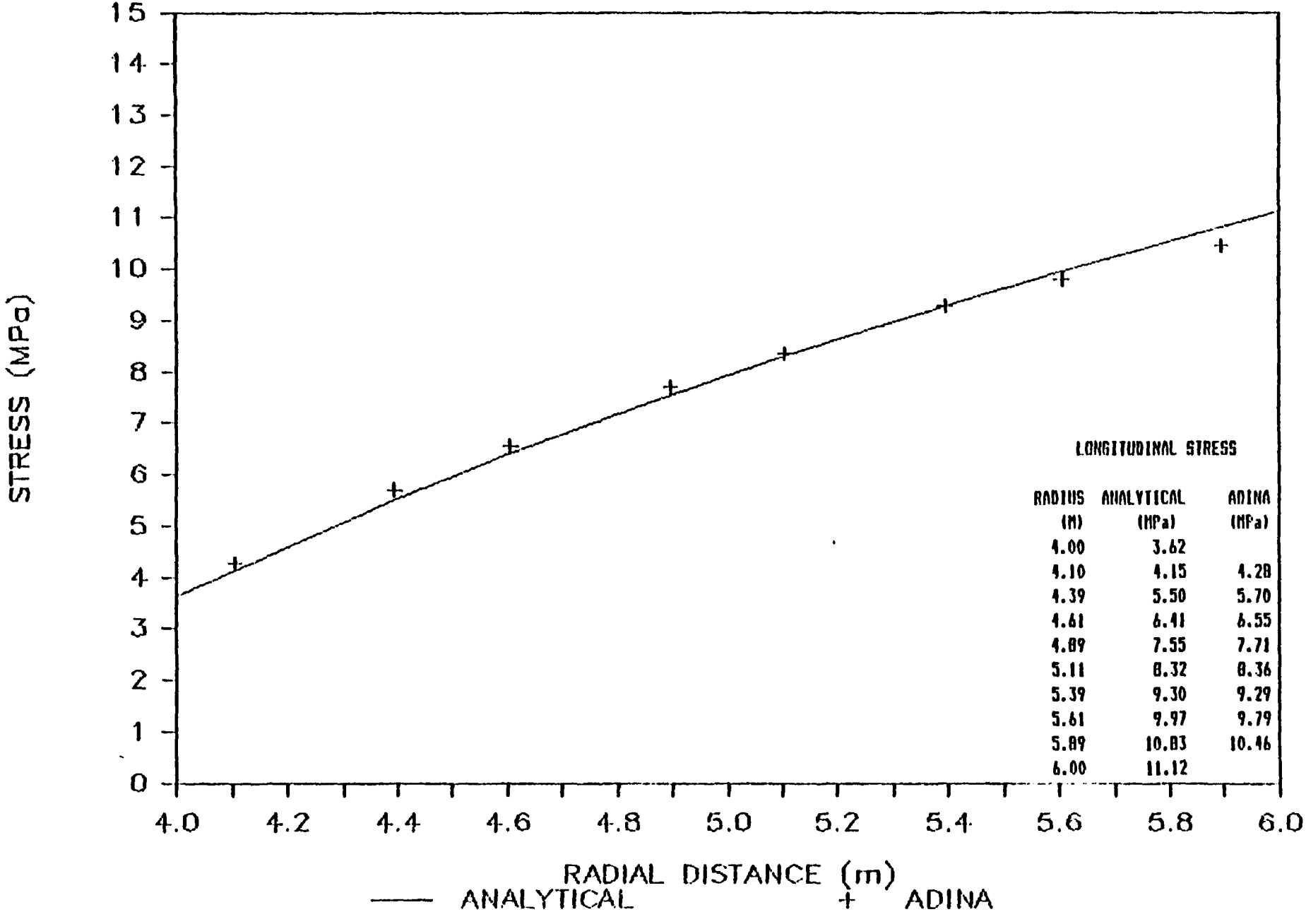
CIRCUMFERENTIAL STRESS

RADIUS (M)	ANALYTICAL (MPa)	ADINA (MPa)
4.00	17.25	
4.10	17.60	17.88
4.39	18.50	18.84
4.61	19.10	19.37
4.89	19.86	20.10
5.11	20.38	20.43
5.39	21.03	20.92
5.61	21.48	21.10
5.89	22.05	21.30
6.00	22.25	

ADINA Problem 3.3c
CIRCUMFERENTIAL STRESS COMPARISON

ADINA — PROBLEM 3.3c

LONGITUDINAL STRESS



LONGITUDINAL STRESS

RADIUS (M)	ANALYTICAL (MPa)	ADINA (MPa)
4.00	3.62	
4.10	4.15	4.28
4.39	5.50	5.70
4.61	6.41	6.55
4.89	7.55	7.71
5.11	8.32	8.36
5.39	9.30	9.29
5.61	9.97	9.79
5.89	10.83	10.46
6.00	11.12	

ADINA Problem 3.3c
LONGITUDINAL STRESS COMPARISON

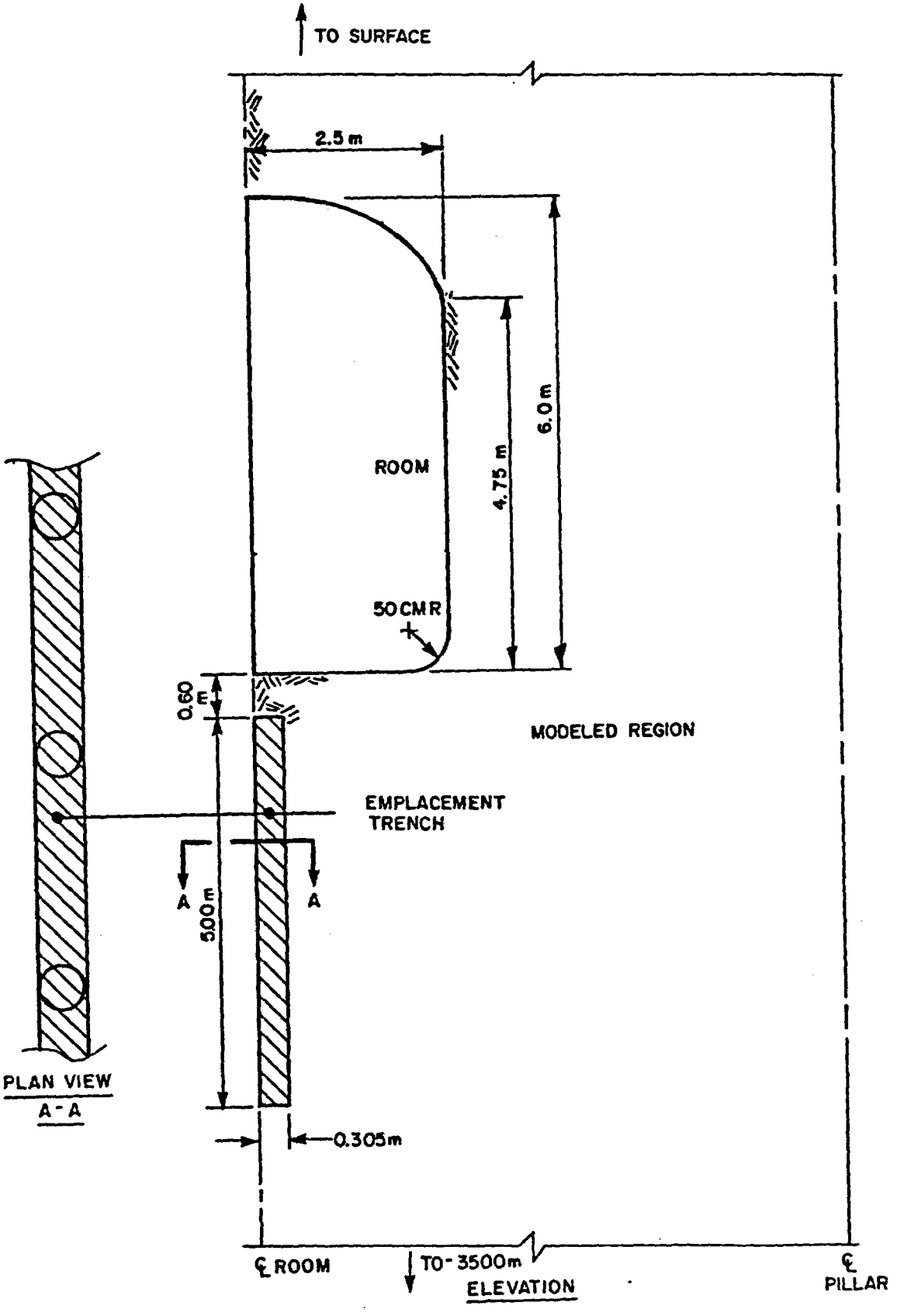


Figure 5.2-1 Near Field (Room) Model

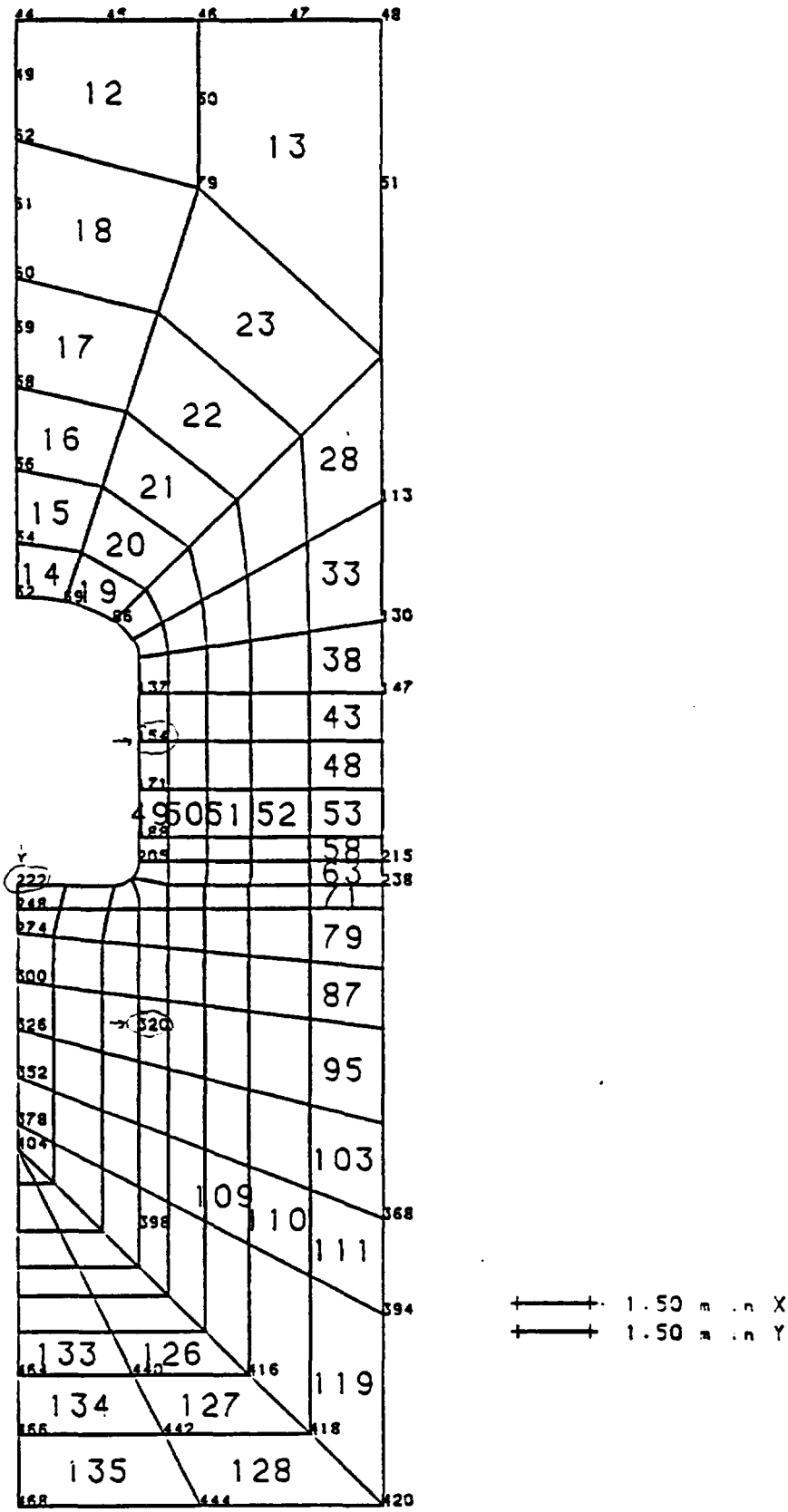
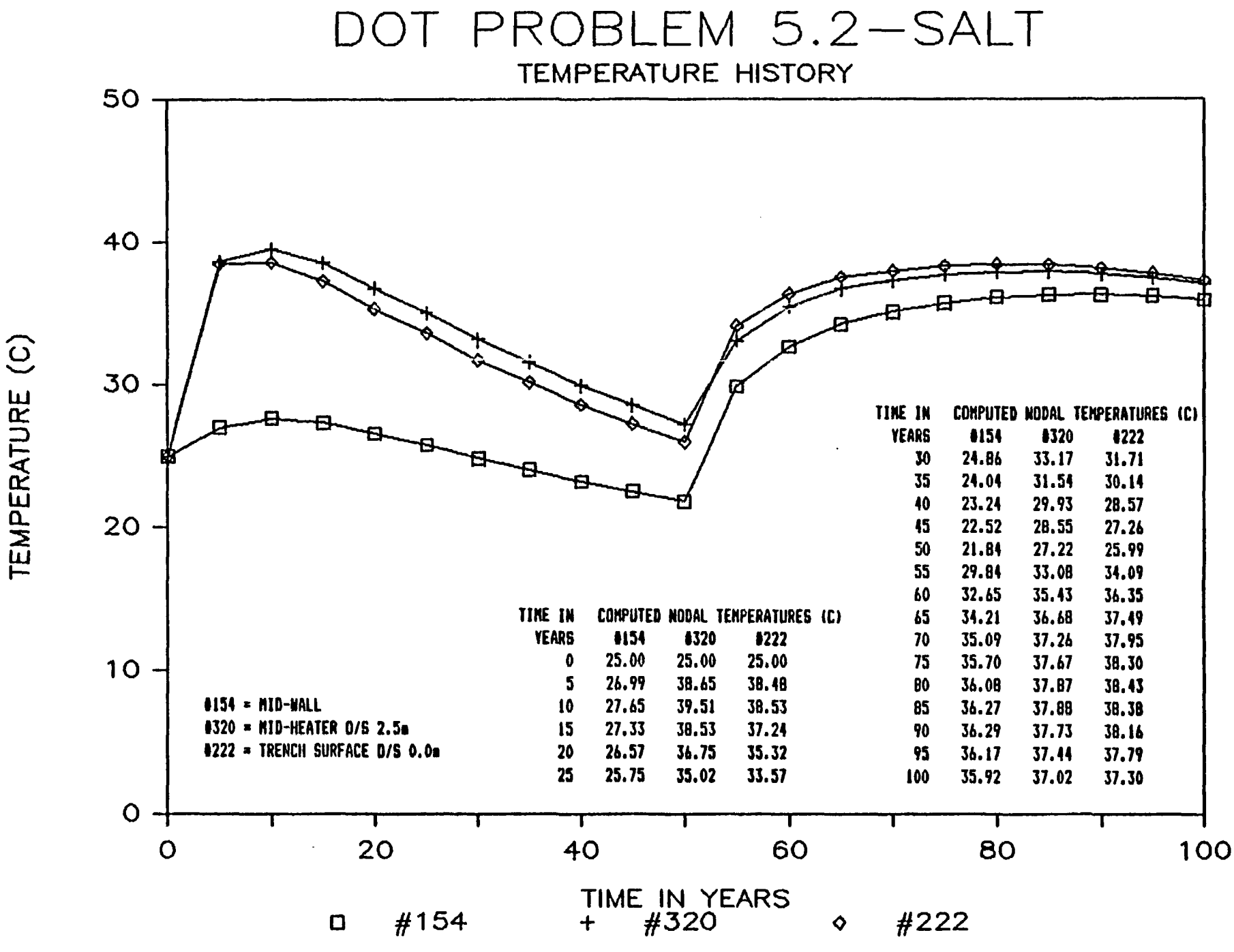


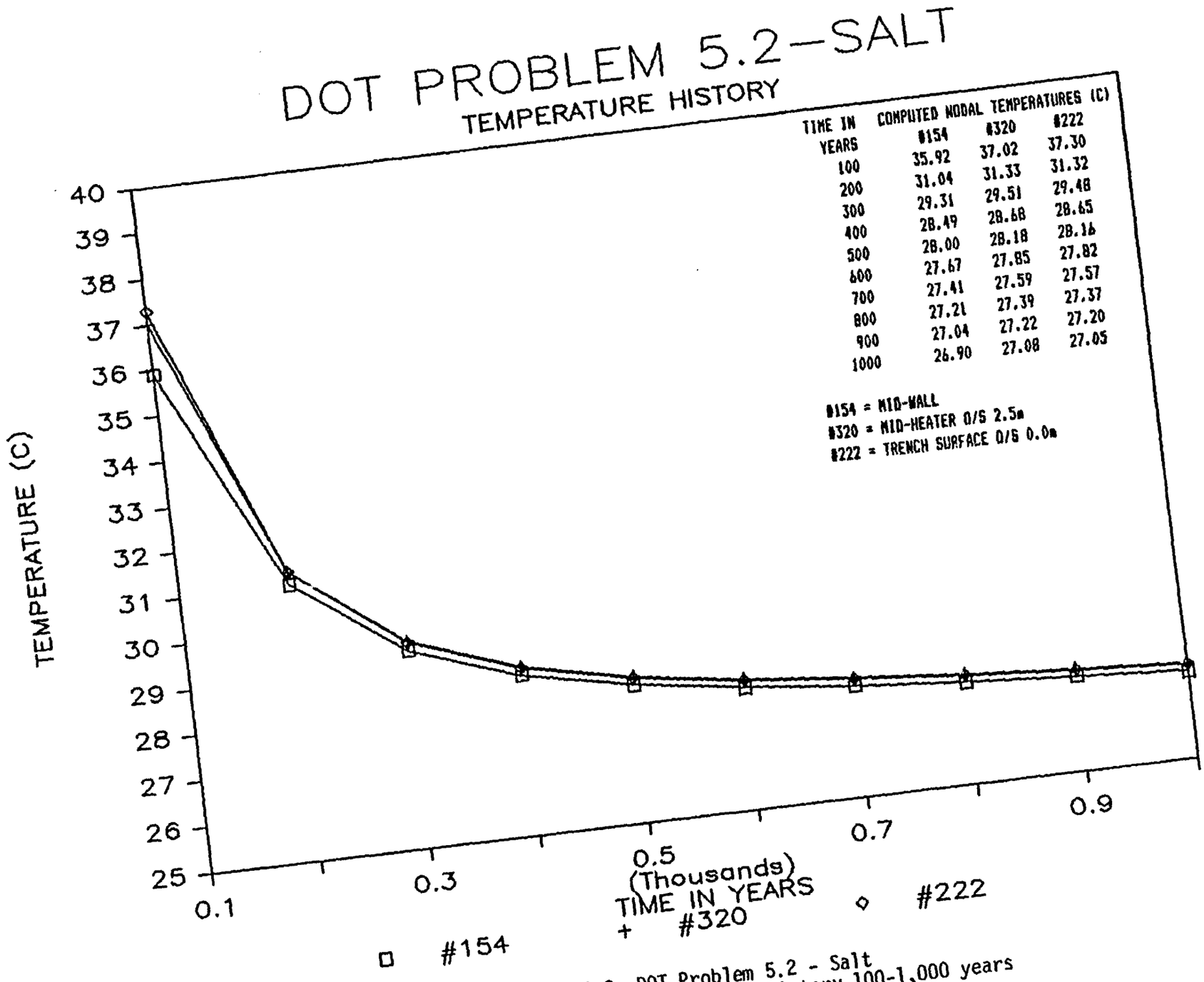
Figure 6.3-1 DOT Problem 5.2
Finite Element Mesh



TIME IN YEARS	COMPUTED NODAL TEMPERATURES (C) #154	#320	#222
0	25.00	25.00	25.00
5	26.99	38.65	38.48
10	27.65	39.51	38.53
15	27.33	38.53	37.24
20	26.57	36.75	35.32
25	25.75	35.02	33.57

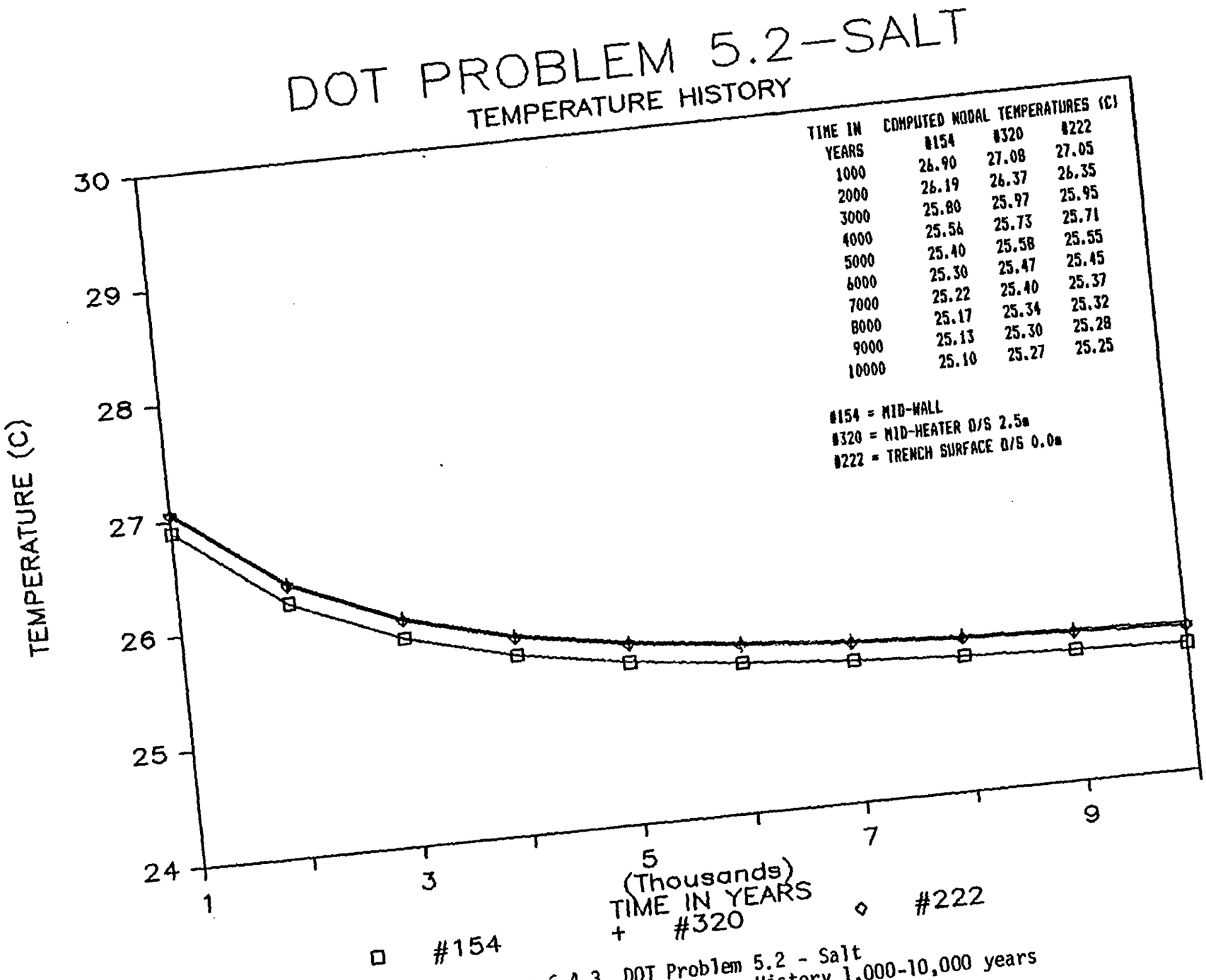
TIME IN YEARS	COMPUTED NODAL TEMPERATURES (C) #154	#320	#222
30	24.86	33.17	31.71
35	24.04	31.54	30.14
40	23.24	29.93	28.57
45	22.52	28.55	27.26
50	21.84	27.22	25.99
55	29.84	33.08	34.09
60	32.65	35.43	36.35
65	34.21	36.68	37.49
70	35.09	37.26	37.95
75	35.70	37.67	38.30
80	36.08	37.87	38.43
85	36.27	37.88	38.38
90	36.29	37.73	38.16
95	36.17	37.44	37.79
100	35.92	37.02	37.30

Figure 6.4-1 DOT Problem 5.2 - Salt
Temperature History 0-100 Years



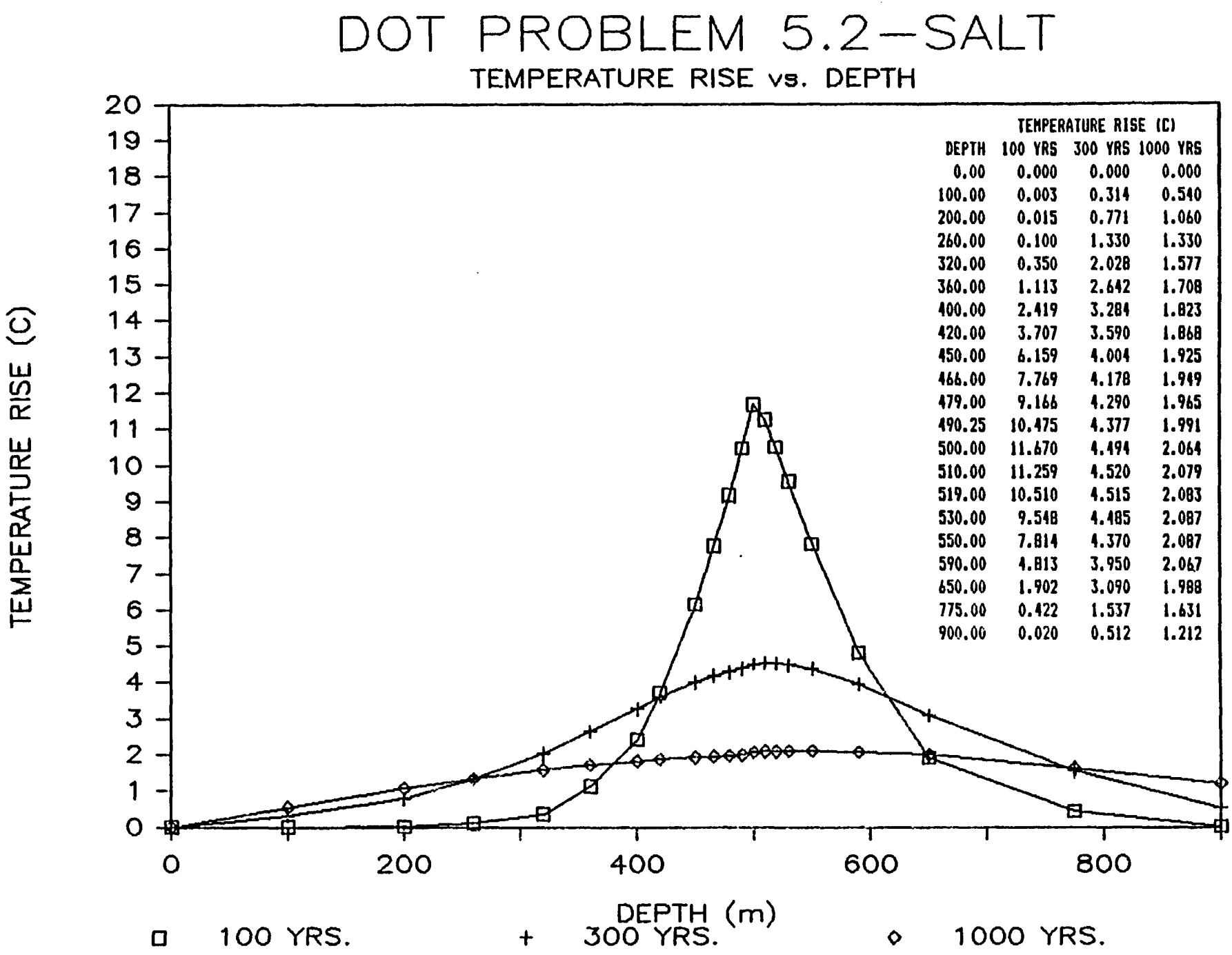
TIME IN YEARS	COMPUTED NODAL TEMPERATURES (C) #154	#320	#222
100	35.92	37.02	37.30
200	31.04	31.33	31.32
300	29.31	29.51	29.48
400	28.49	28.68	28.65
500	28.00	28.18	28.16
600	27.67	27.85	27.82
700	27.41	27.59	27.57
800	27.21	27.39	27.37
900	27.04	27.22	27.20
1000	26.90	27.08	27.05

Figure 6.4-2 DOT Problem 5.2 - Salt
Temperature History 100-1,000 years



TIME IN YEARS	COMPUTED NODAL TEMPERATURES (C) #154	#320	#222
1000	26.90	27.08	27.05
2000	26.19	26.37	26.35
3000	25.80	25.97	25.95
4000	25.56	25.73	25.71
5000	25.40	25.58	25.55
6000	25.30	25.47	25.45
7000	25.22	25.40	25.37
8000	25.17	25.34	25.32
9000	25.13	25.30	25.28
10000	25.10	25.27	25.25

Figure 6.4-3 DOT Problem 5.2 - Salt Temperature History 1,000-10,000 years



	TEMPERATURE RISE (C)		
DEPTH	100 YRS	300 YRS	1000 YRS
0.00	0.000	0.000	0.000
100.00	0.003	0.314	0.540
200.00	0.015	0.771	1.060
260.00	0.100	1.330	1.330
320.00	0.350	2.028	1.577
360.00	1.113	2.642	1.708
400.00	2.419	3.284	1.823
420.00	3.707	3.590	1.868
450.00	6.159	4.004	1.925
466.00	7.769	4.178	1.949
479.00	9.166	4.290	1.965
490.25	10.475	4.377	1.991
500.00	11.670	4.494	2.064
510.00	11.259	4.520	2.079
519.00	10.510	4.515	2.083
530.00	9.548	4.485	2.087
550.00	7.814	4.370	2.087
590.00	4.813	3.950	2.067
650.00	1.902	3.090	1.988
775.00	0.422	1.537	1.631
900.00	0.020	0.512	1.212

Figure 6.4-5 DOT Problem 5.2 - Salt
Temperature Rise along
Pillar Centerline (100-1,000 years)

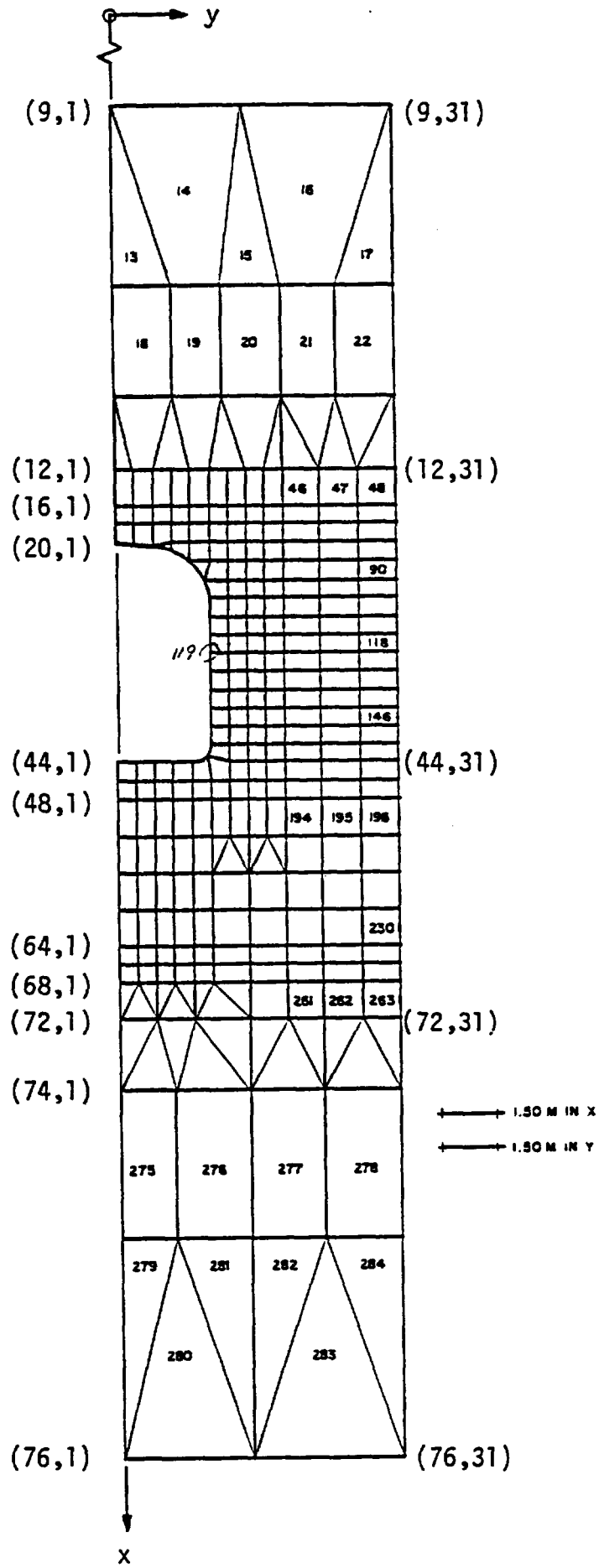
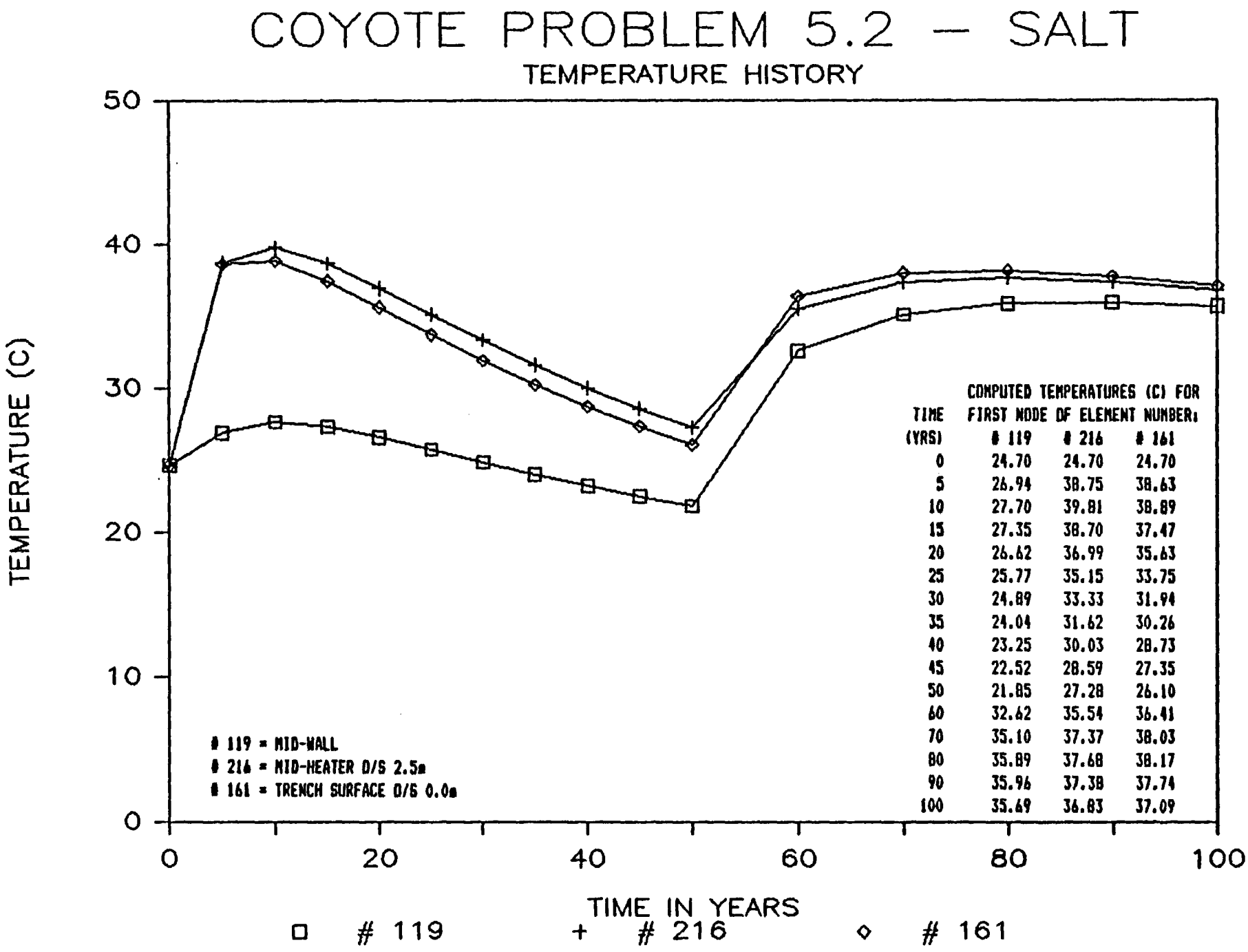
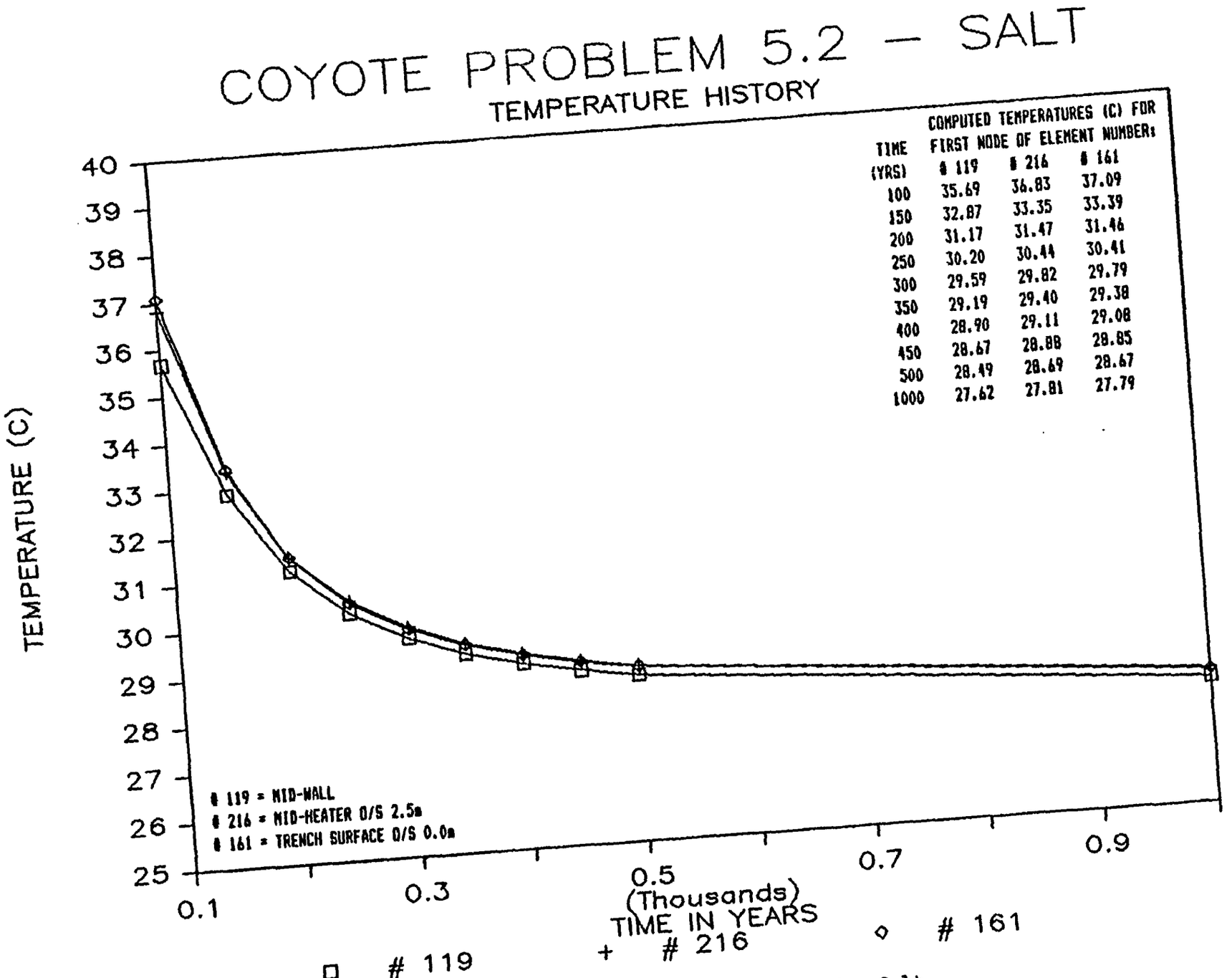


Figure 10.5-1 COYOTE Problem 5.2S
Finite Element Mesh



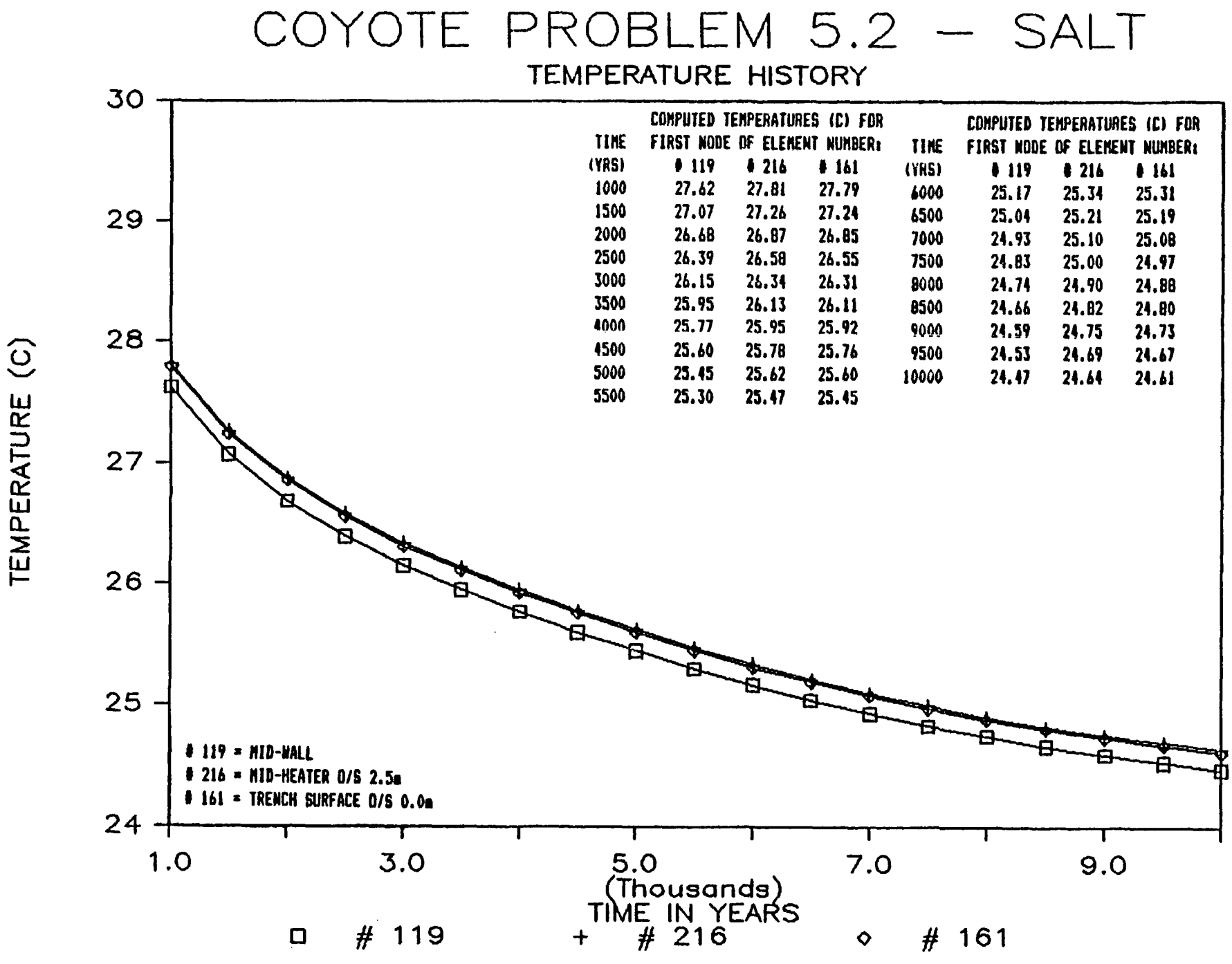
TIME (YRS)	COMPUTED TEMPERATURES (C) FOR FIRST NODE OF ELEMENT NUMBER: # 119	# 216	# 161
0	24.70	24.70	24.70
5	26.94	38.75	38.63
10	27.70	39.81	38.89
15	27.35	38.70	37.47
20	26.62	36.99	35.63
25	25.77	35.15	33.75
30	24.89	33.33	31.94
35	24.04	31.62	30.26
40	23.25	30.03	28.73
45	22.52	28.59	27.35
50	21.85	27.28	26.10
60	32.62	35.54	36.41
70	35.10	37.37	38.03
80	35.89	37.68	38.17
90	35.96	37.38	37.74
100	35.69	36.83	37.09

Figure 10.5-3 COYOTE Problem 5.2 - Salt
Temperature History 0-100 years



TIME (YRS)	COMPUTED TEMPERATURES (C) FOR FIRST NODE OF ELEMENT NUMBER: # 119	# 216	# 161
100	35.69	36.83	37.09
150	32.87	33.35	33.39
200	31.17	31.47	31.46
250	30.20	30.44	30.41
300	29.59	29.82	29.79
350	29.19	29.40	29.38
400	28.90	29.11	29.08
450	28.67	28.88	28.85
500	28.49	28.69	28.67
1000	27.62	27.81	27.79

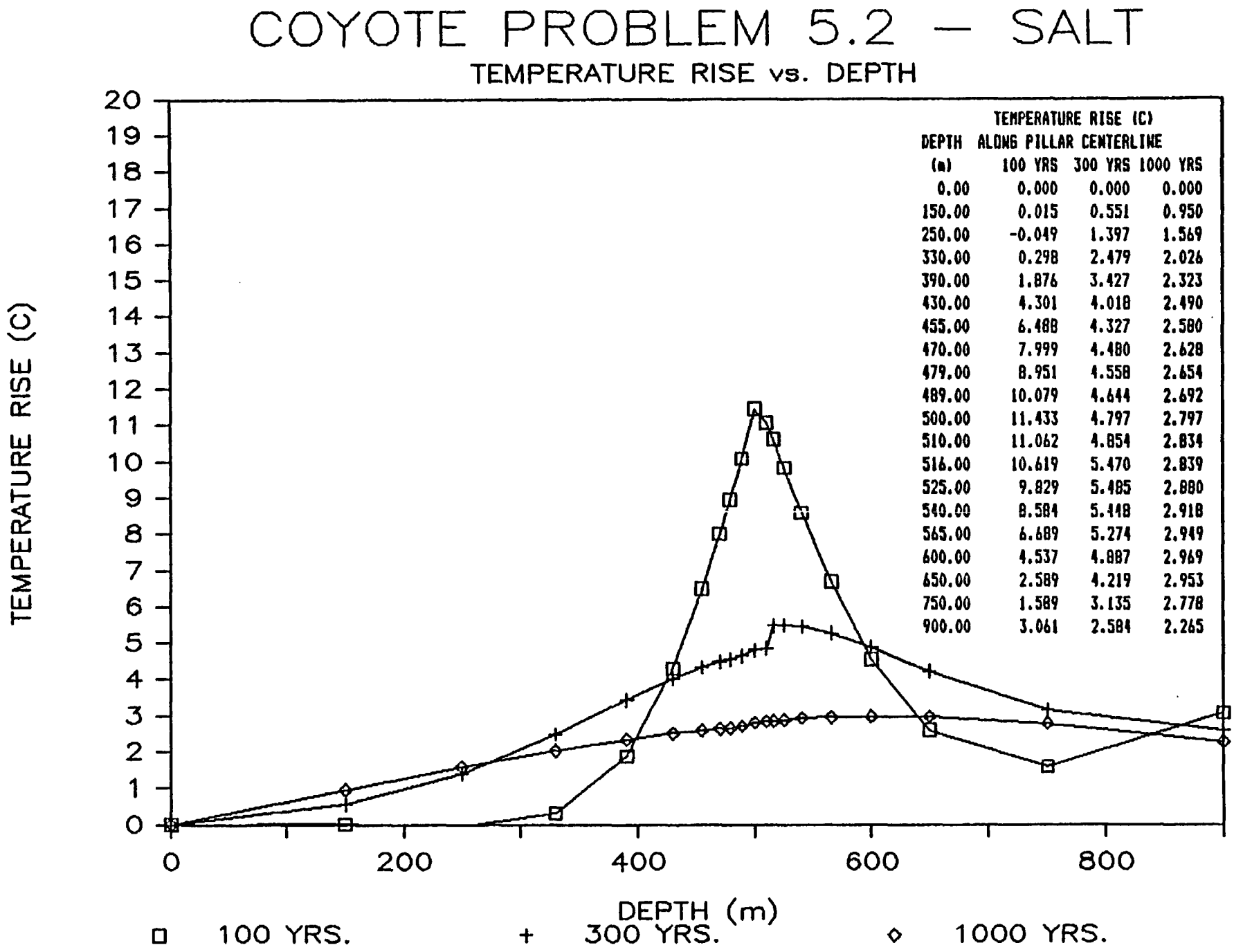
Figure 10.5-4 COYOTE Problem 5.2 - Salt
Temperature History 100-1,000 years



TIME (YRS)	COMPUTED TEMPERATURES (C) FOR FIRST NODE OF ELEMENT NUMBER: # 119	# 216	# 161
1000	27.62	27.81	27.79
1500	27.07	27.26	27.24
2000	26.68	26.87	26.85
2500	26.39	26.58	26.55
3000	26.15	26.34	26.31
3500	25.95	26.13	26.11
4000	25.77	25.95	25.92
4500	25.60	25.78	25.76
5000	25.45	25.62	25.60
5500	25.30	25.47	25.45

TIME (YRS)	COMPUTED TEMPERATURES (C) FOR FIRST NODE OF ELEMENT NUMBER: # 119	# 216	# 161
6000	25.17	25.34	25.31
6500	25.04	25.21	25.19
7000	24.93	25.10	25.08
7500	24.83	25.00	24.97
8000	24.74	24.90	24.88
8500	24.66	24.82	24.80
9000	24.59	24.75	24.73
9500	24.53	24.69	24.67
10000	24.47	24.64	24.61

Figure 10.5-5 COYOTE Problem 5.2 - Salt
Temperature History 1,000-10,000 years



DEPTH (m)	TEMPERATURE RISE (C) ALONG PILLAR CENTERLINE 100 YRS	300 YRS	1000 YRS
0.00	0.000	0.000	0.000
150.00	0.015	0.551	0.950
250.00	-0.049	1.397	1.569
330.00	0.298	2.479	2.026
390.00	1.876	3.427	2.323
430.00	4.301	4.018	2.490
455.00	6.488	4.327	2.580
470.00	7.999	4.480	2.628
479.00	8.951	4.558	2.654
489.00	10.079	4.644	2.692
500.00	11.433	4.797	2.797
510.00	11.062	4.854	2.834
516.00	10.619	5.470	2.839
525.00	9.829	5.485	2.880
540.00	8.584	5.448	2.918
565.00	6.689	5.274	2.949
600.00	4.537	4.887	2.969
650.00	2.589	4.219	2.953
750.00	1.589	3.135	2.778
900.00	3.061	2.584	2.265

Figure 10.5-7 COYOTE Problem 5.2 - Salt
Temperature Rise (100-1,000 years)
along Pillar Centerline

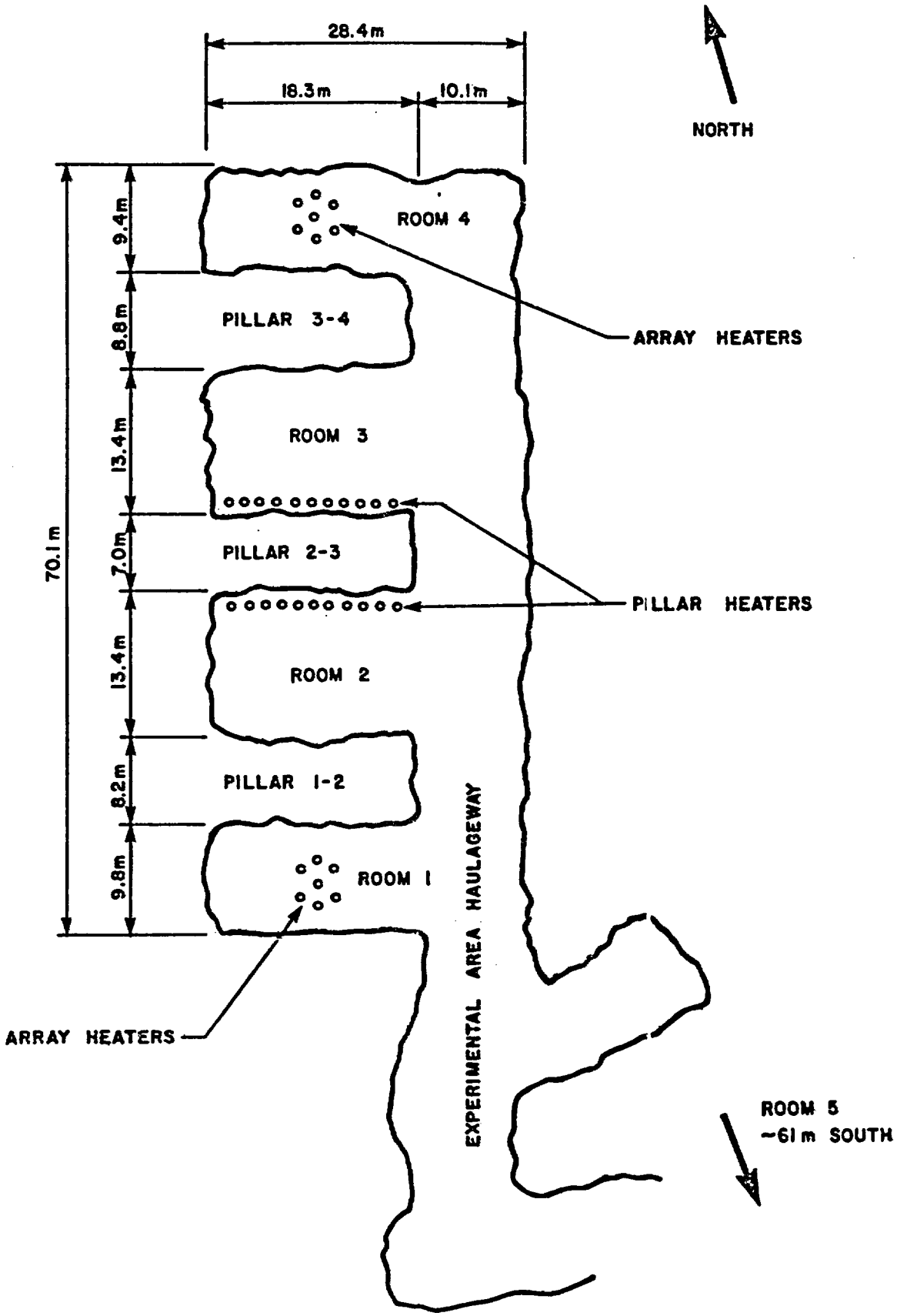


Figure 6.1-1 Plan of Project Salt Vault Experimental Area (From Ratigan and Callahan, 1978)

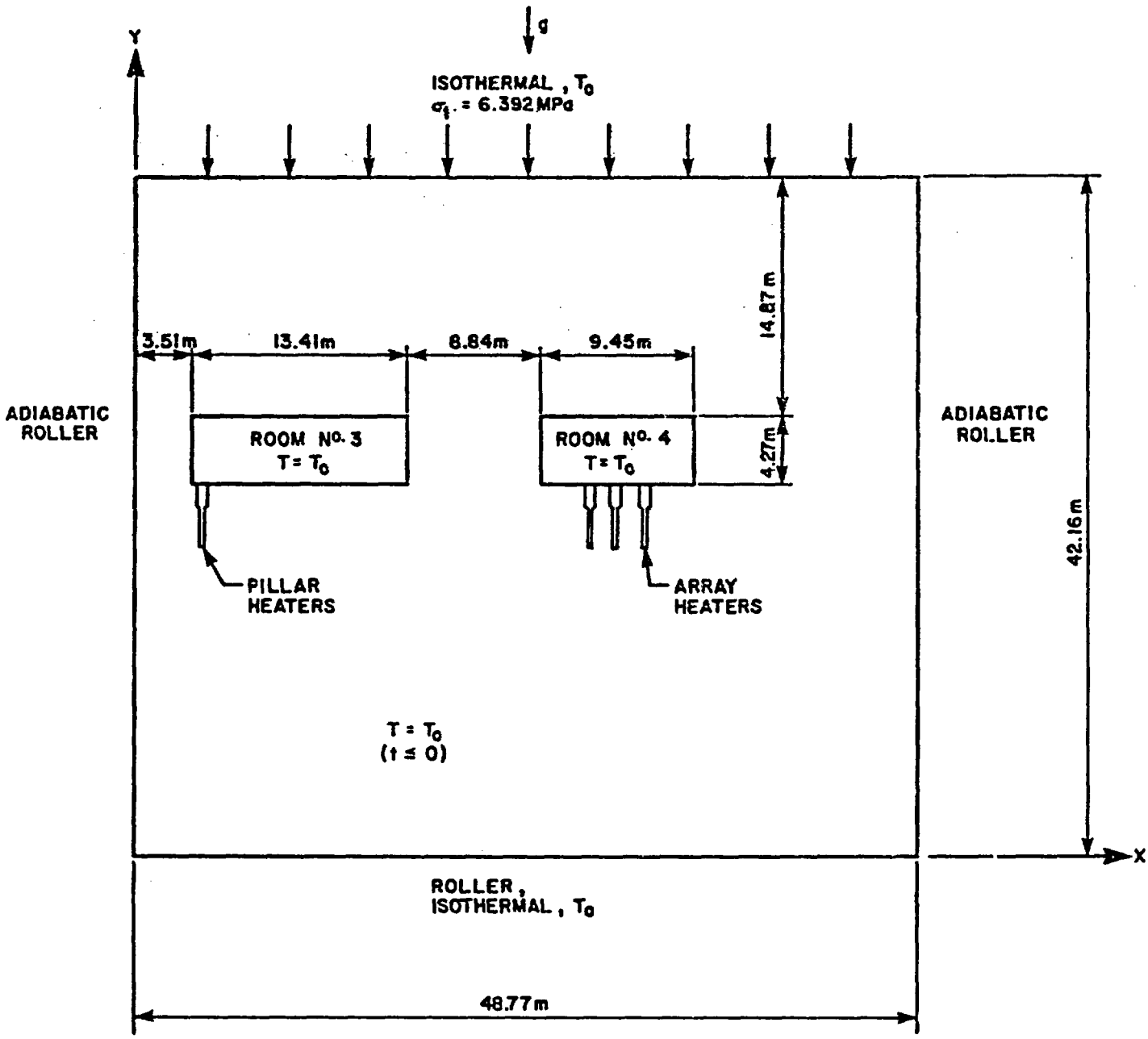


Figure 6.1-3 Sketch of Benchmark - Problem 6.1

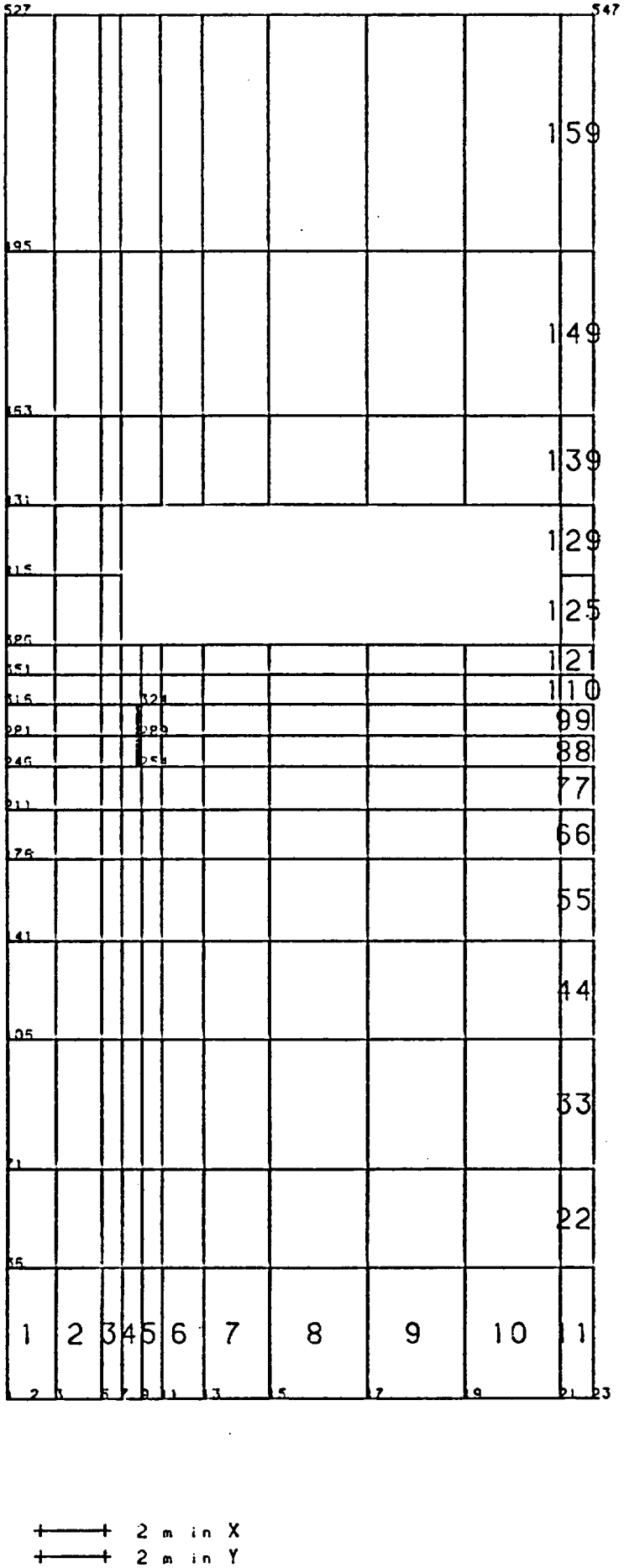


Figure 6.5-1 DOT Problem 6.1P - Room 3
Finite Element Mesh

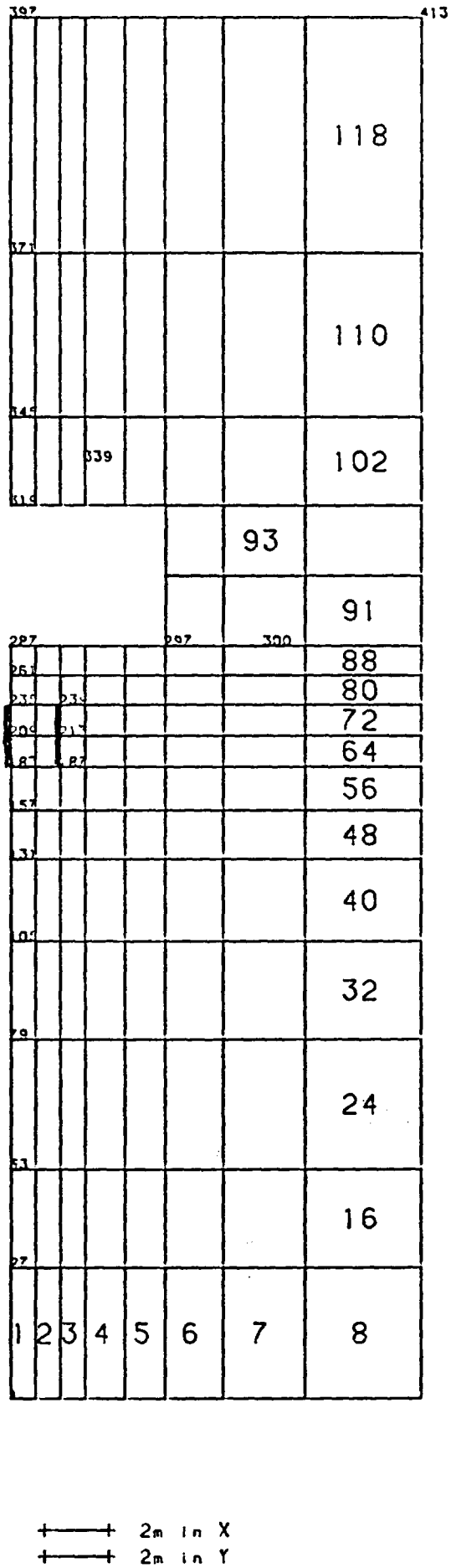


Figure 6.5-2 Problem 6.1A - Room 4
Finite Element Mesh

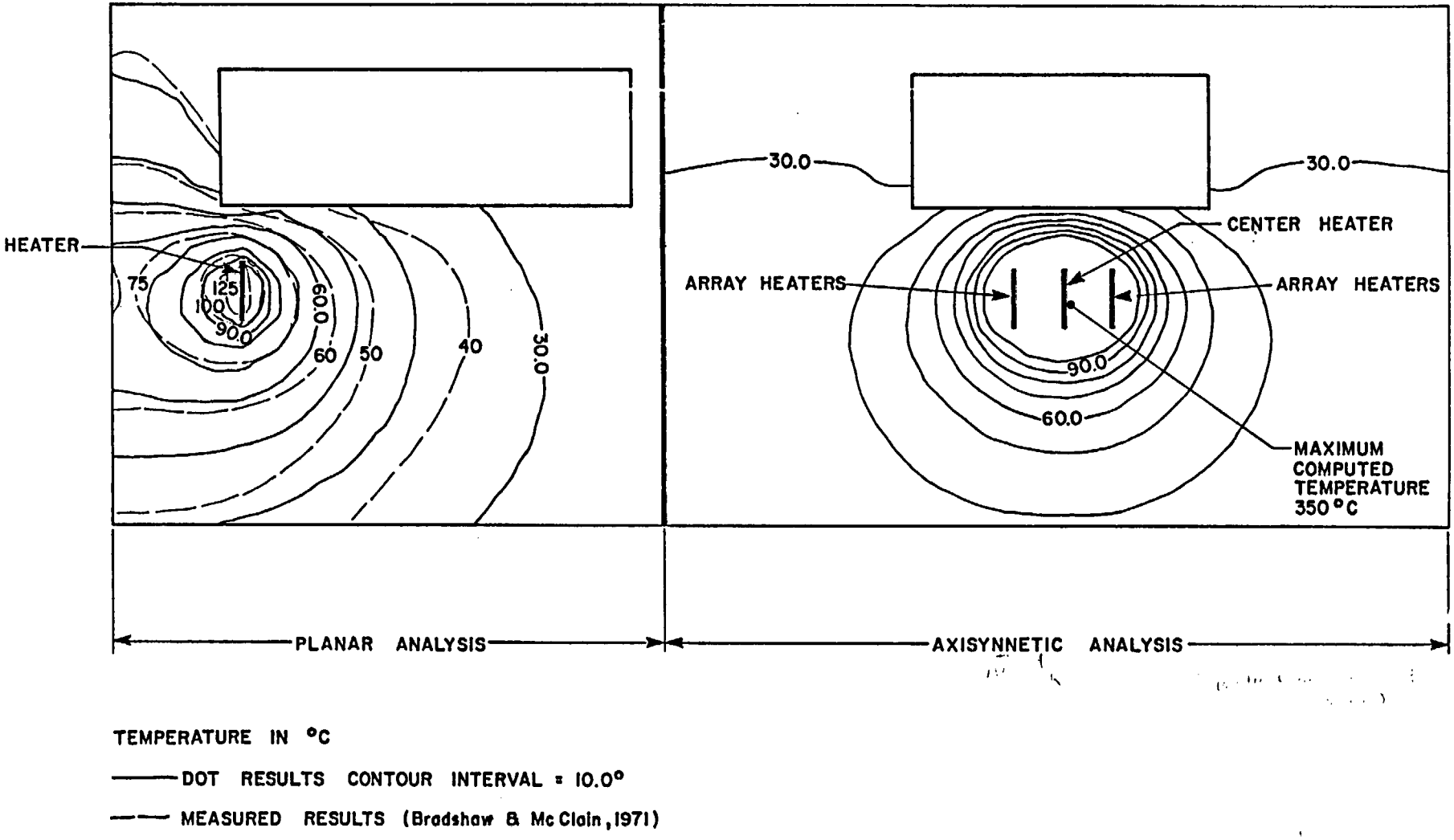
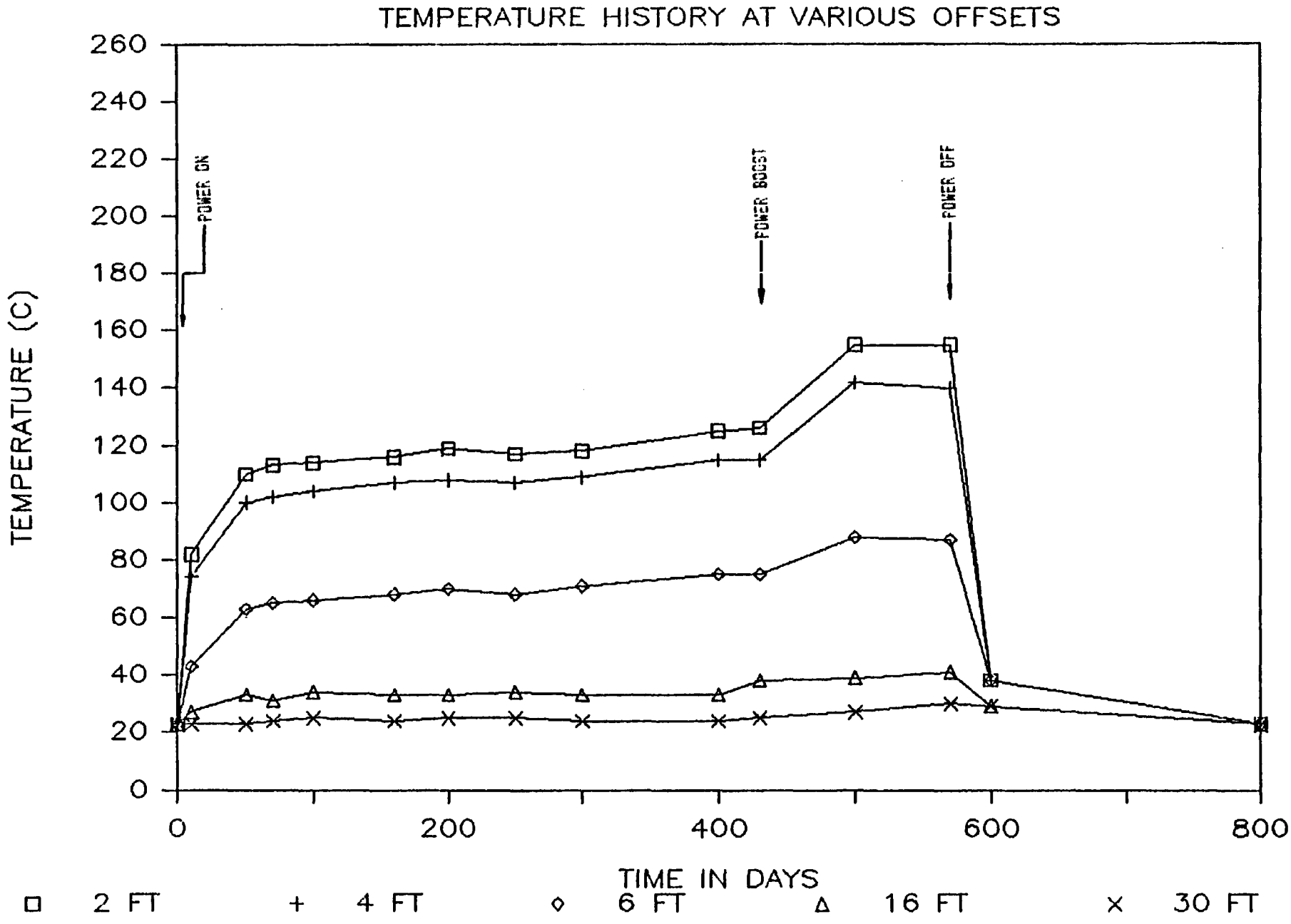
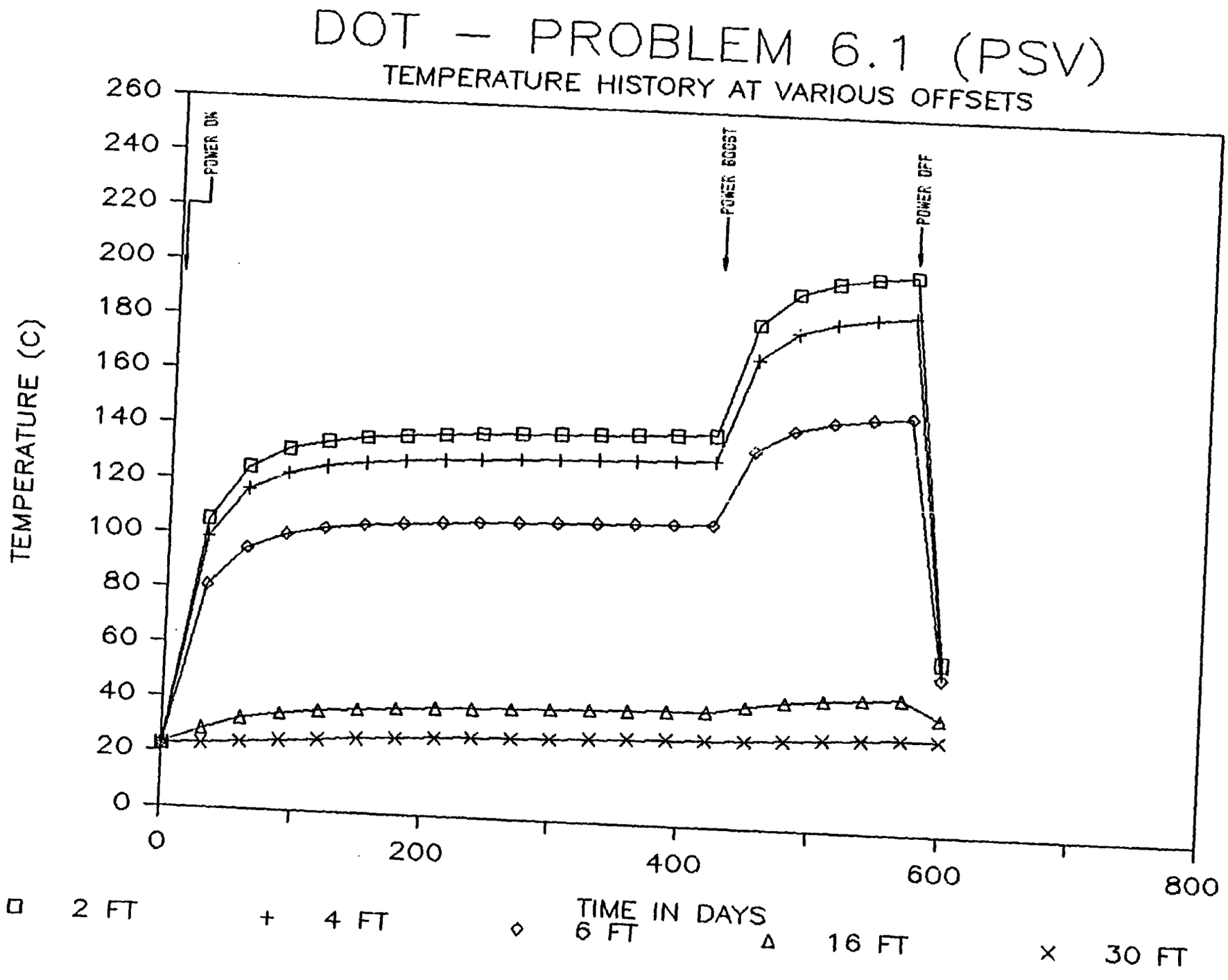


Figure 6.5-7 DOT Problem 6.1
Temperature Contours at Day 570

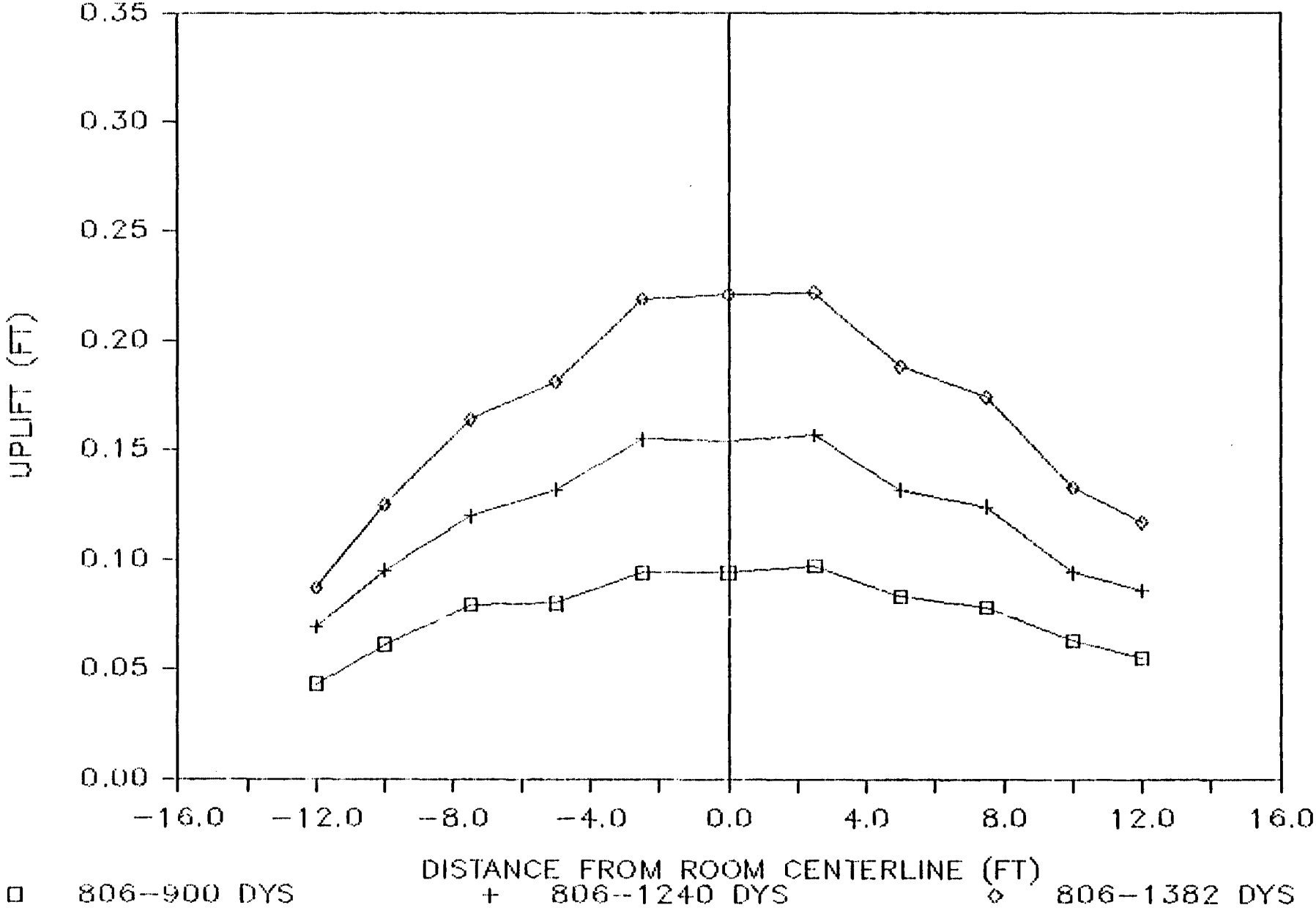
DOT – PROBLEM 6.1 (PSV) FIELD VALUES




DOT – PROBLEM 6.1 (PSV)
TEMPERATURE HISTORY AT VARIOUS OFFSETS
POWER ON
POWER BOOST
POWER OFF
TEMPERATURE (C)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
200
400
600
800
TIME IN DAYS
2 FT
4 FT
6 FT
16 FT
30 FT

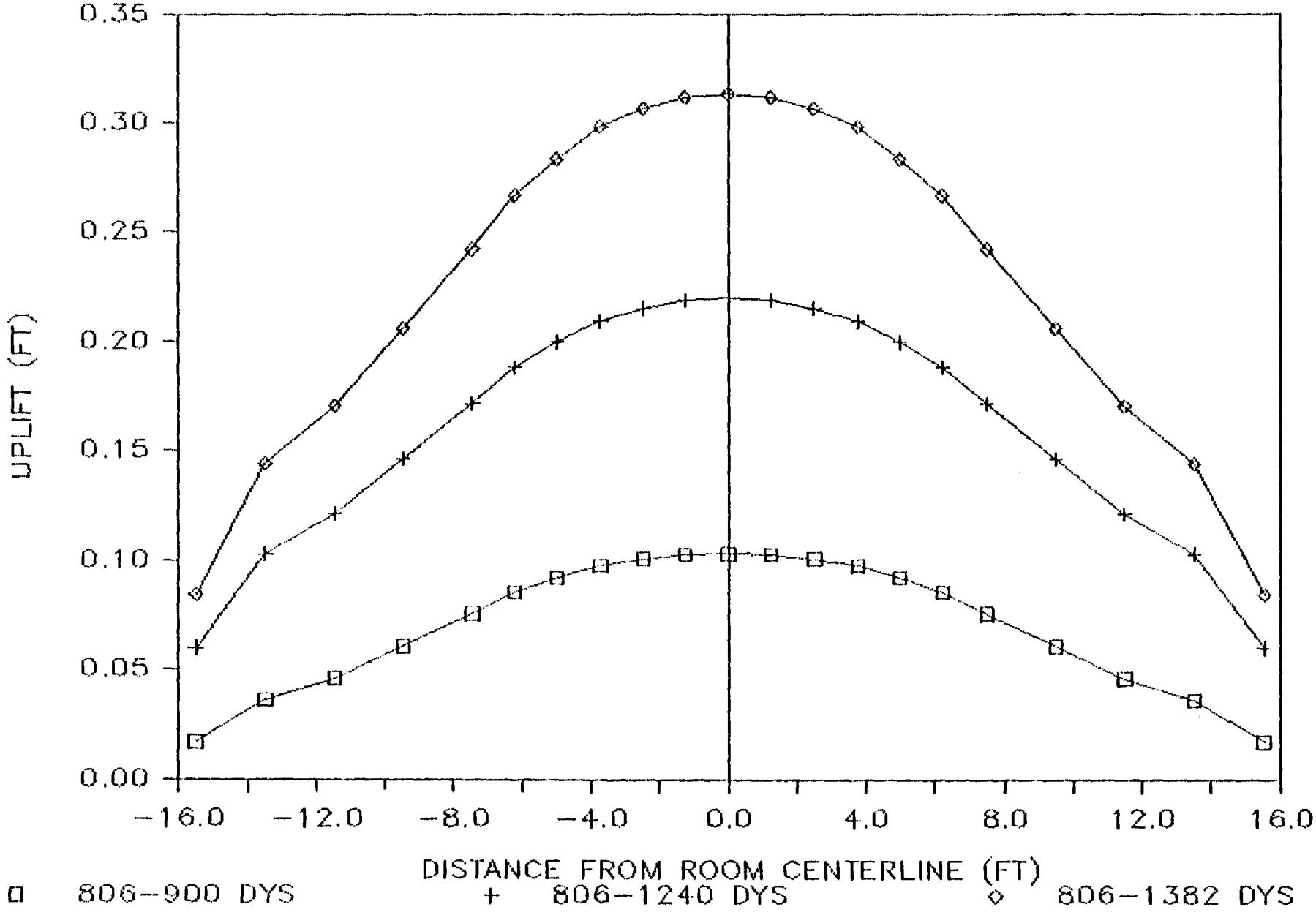
VISCOT — PROB.6.1 (PSV) FIELD VALUES

ROOM 4 – FLOOR UPLIFT AT VARIOUS TIMES

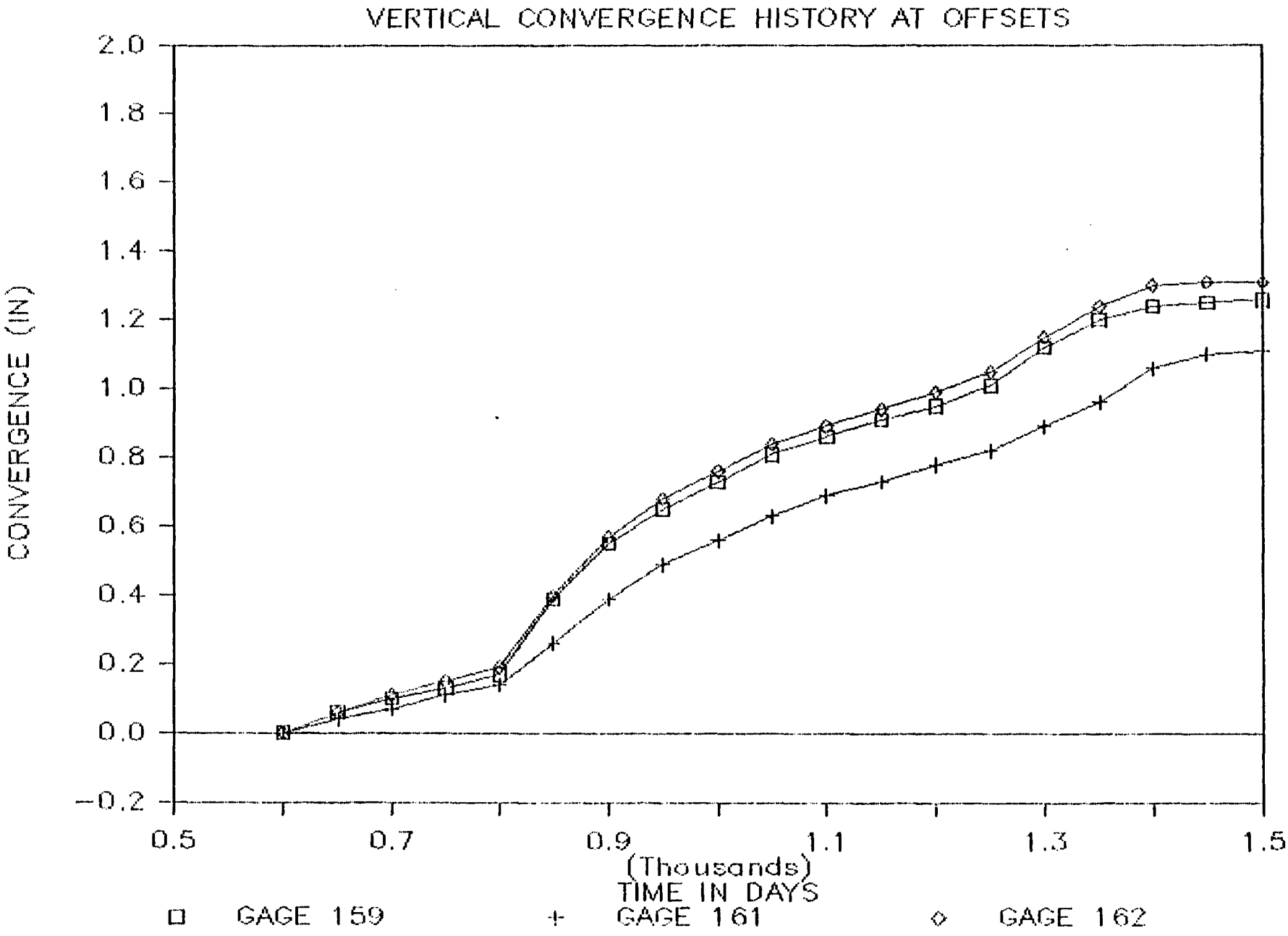


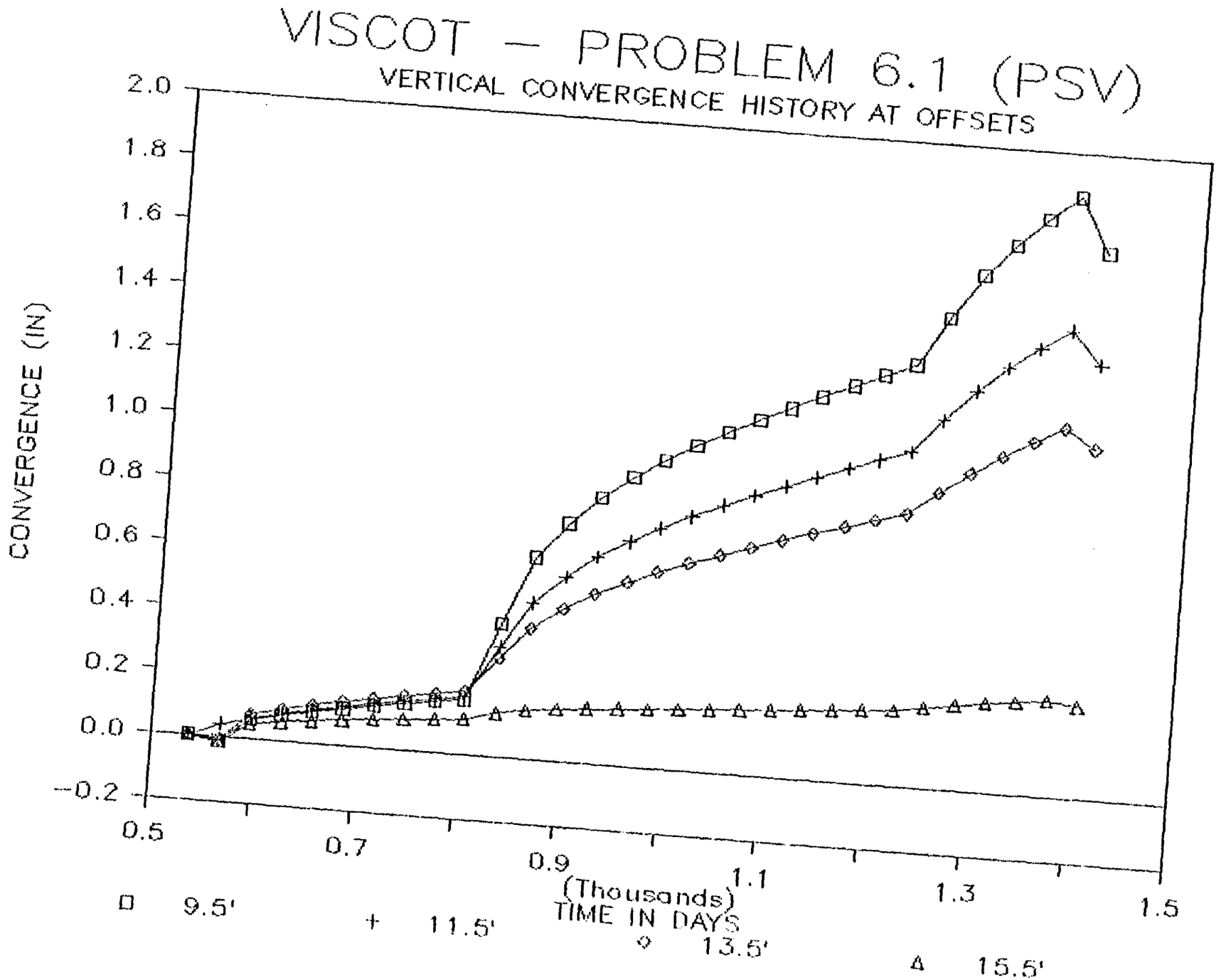
VISCOT – PROBLEM 6.1 (PSV)

ROOM 4 – FLOOR UPLIFT AT VARIOUS TIMES



VISCOT — PROB. 6.1 (PSV) FIELD VALUES




VISCOT – PROBLEM 6.1 (PSV)
VERTICAL CONVERGENCE HISTORY AT OFFSETS
CONVERGENCE (IN)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
0.5
0.7
0.9
1.1
1.3
1.5
(Thousands)
TIME IN DAYS
9.5'
11.5'
13.5'
15.5'

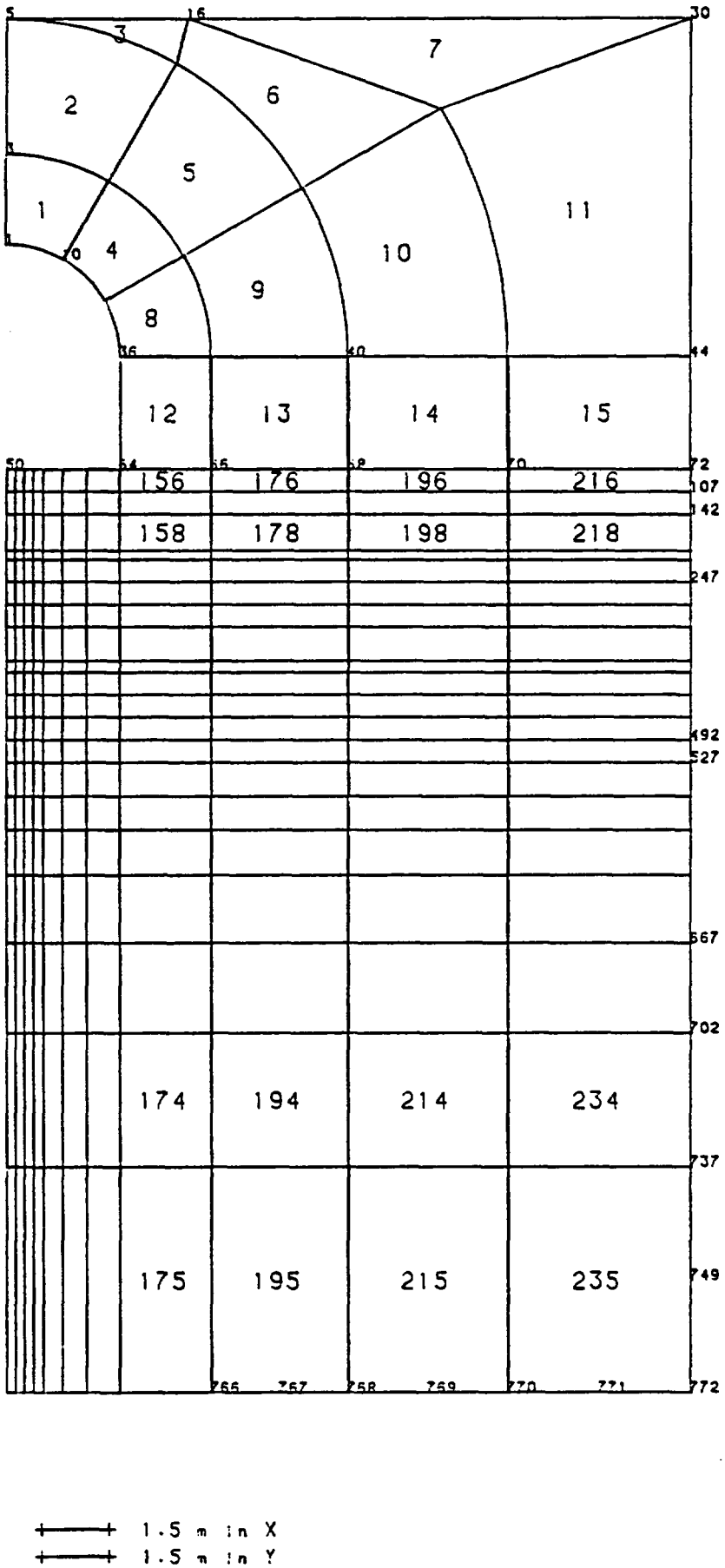
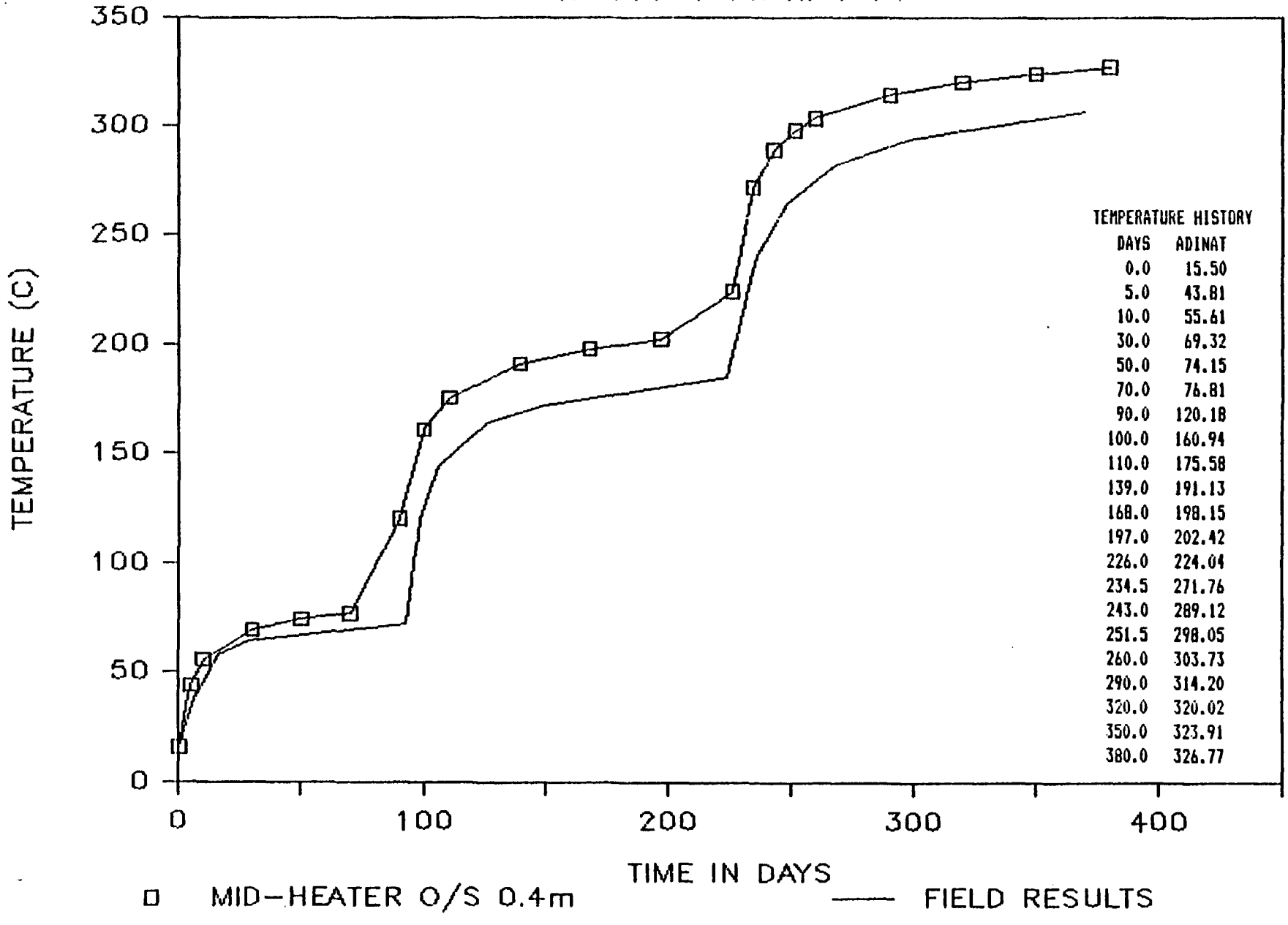


Figure 6.6-1 DOT Problem 6.3
Finite Element Mesh

ADINAT PROBLEM 6.3 — BWIP

TEMPERATURE HISTORY

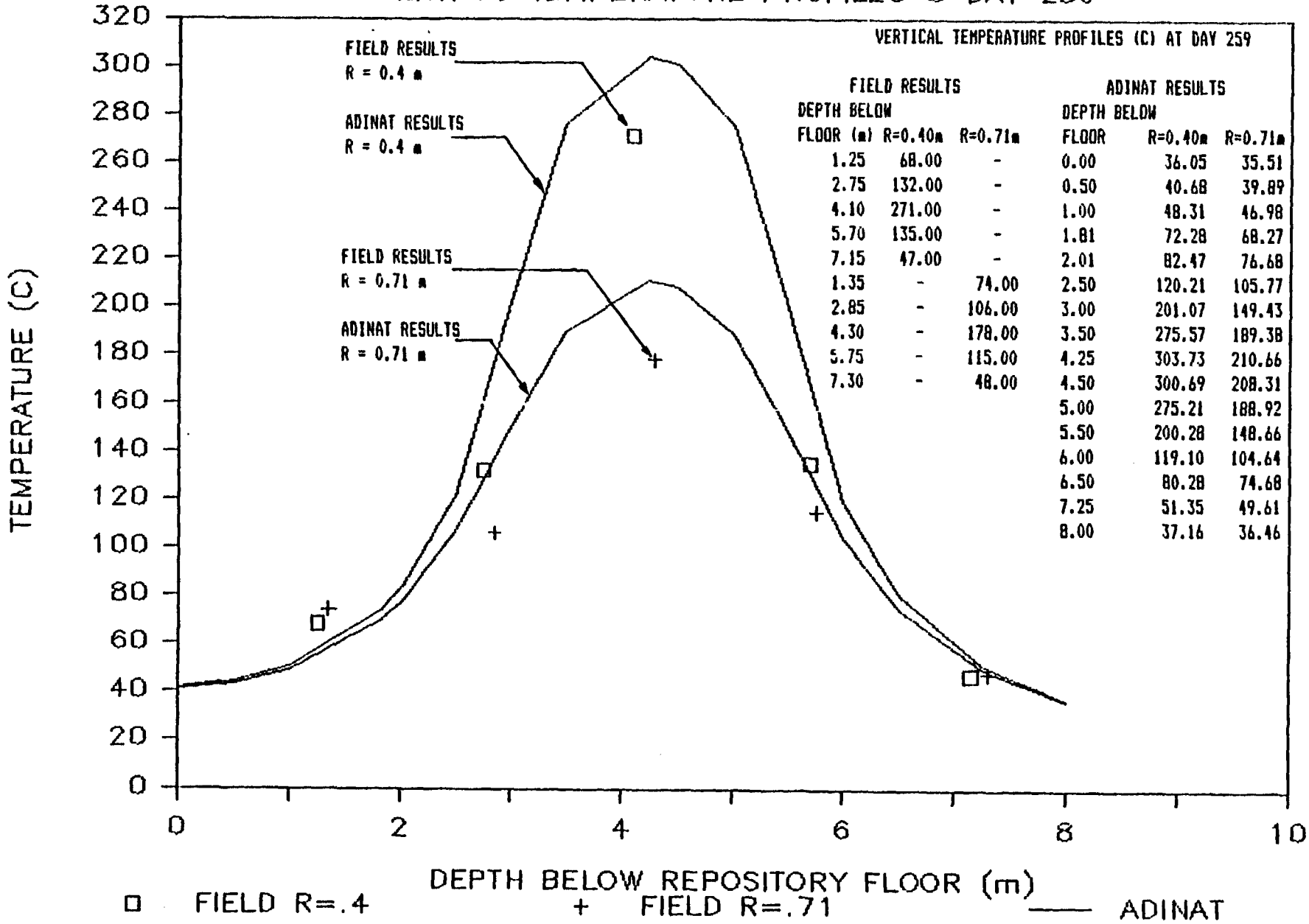


TEMPERATURE HISTORY

DAYS	ADINAT
0.0	15.50
5.0	43.81
10.0	55.61
30.0	69.32
50.0	74.15
70.0	76.81
90.0	120.18
100.0	160.94
110.0	175.58
139.0	191.13
168.0	198.15
197.0	202.42
226.0	224.04
234.5	271.76
243.0	289.12
251.5	298.05
260.0	303.73
290.0	314.20
320.0	320.02
350.0	323.91
380.0	326.77

ADINAT PROBLEM 6.3 — BWIP

VERTICAL TEMPERATURE PROFILES @ DAY 259



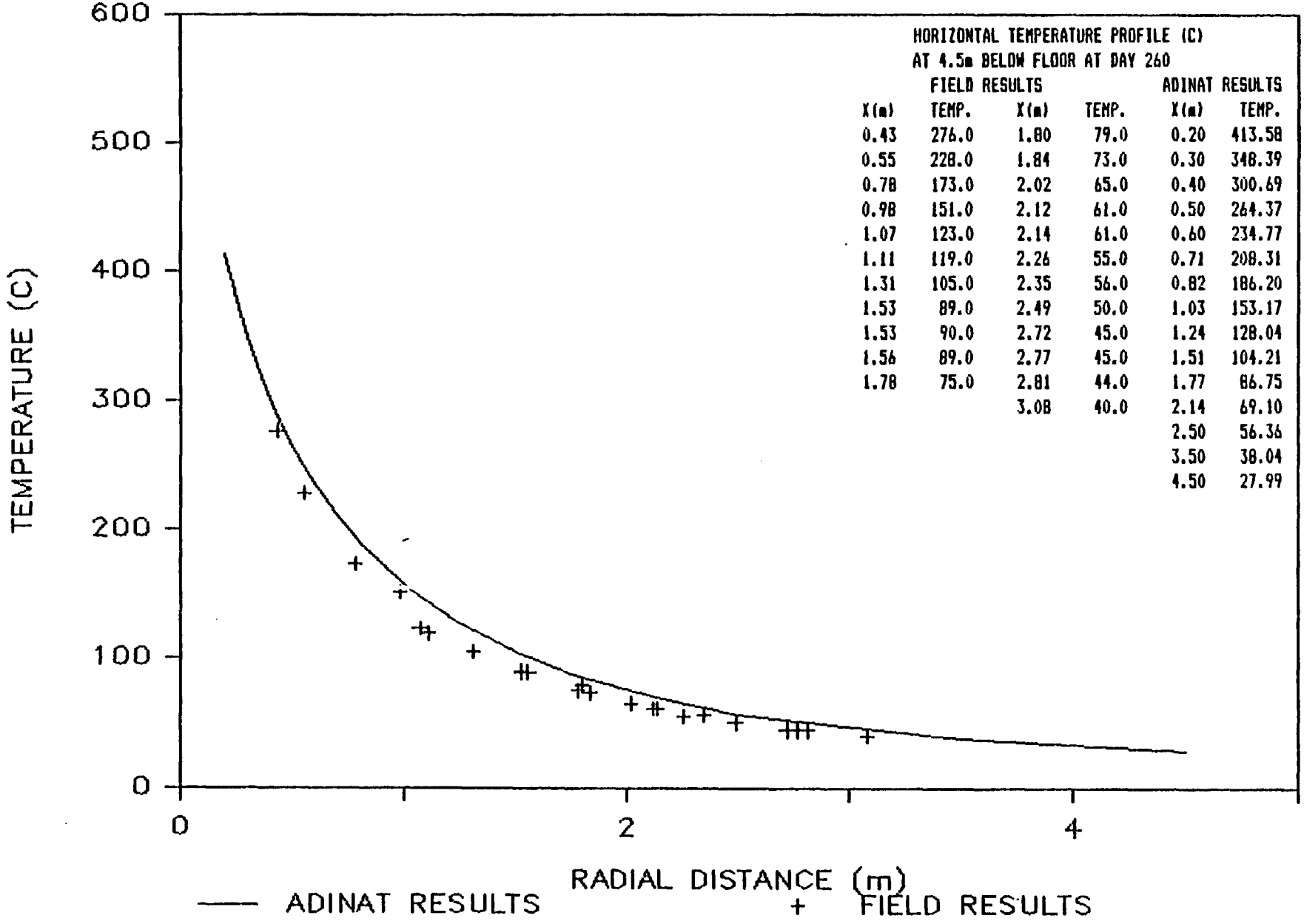
VERTICAL TEMPERATURE PROFILES (C) AT DAY 259

FIELD RESULTS DEPTH BELOW FLOOR (m)	R=0.40m	R=0.71m
1.25	68.00	-
2.75	132.00	-
4.10	271.00	-
5.70	135.00	-
7.15	47.00	-
1.35	-	74.00
2.85	-	106.00
4.30	-	178.00
5.75	-	115.00
7.30	-	48.00

ADINAT RESULTS DEPTH BELOW FLOOR	R=0.40m	R=0.71m
0.00	36.05	35.51
0.50	40.68	39.89
1.00	48.31	46.98
1.81	72.28	68.27
2.01	82.47	76.68
2.50	120.21	105.77
3.00	201.07	149.43
3.50	275.57	189.38
4.25	303.73	210.66
4.50	300.69	208.31
5.00	275.21	188.92
5.50	200.28	148.66
6.00	119.10	104.64
6.50	80.28	74.68
7.25	51.35	49.61
8.00	37.16	36.46

ADINAT PROBLEM 6.3 — BWIP

RADIAL TEMPERATURES ON DAY 260

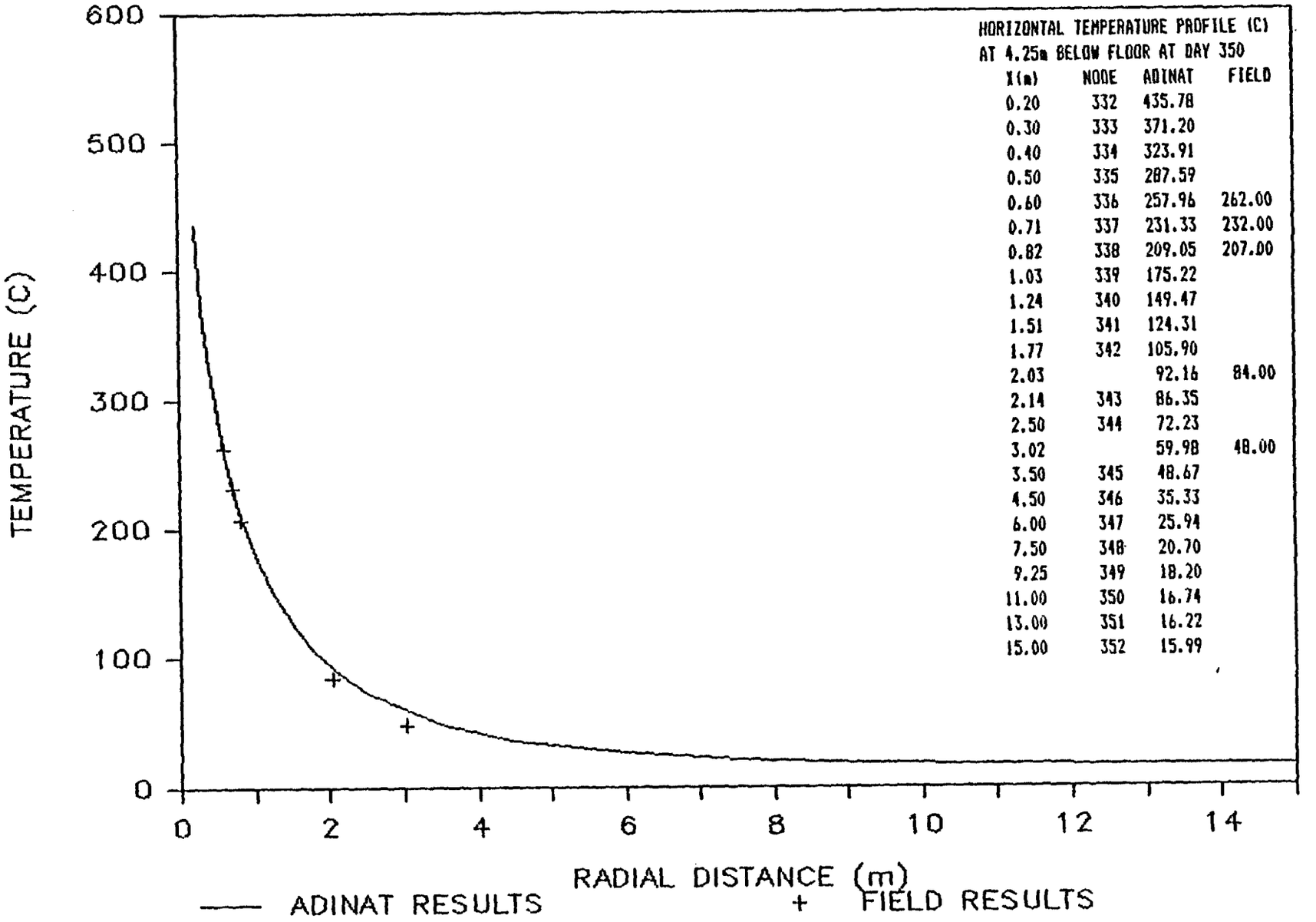


HORIZONTAL TEMPERATURE PROFILE (C)
AT 4.5m BELOW FLOOR AT DAY 260

FIELD RESULTS				ADINAT RESULTS	
X(m)	TEMP.	X(m)	TEMP.	X(m)	TEMP.
0.43	276.0	1.80	79.0	0.20	413.58
0.55	228.0	1.84	73.0	0.30	348.39
0.78	173.0	2.02	65.0	0.40	300.69
0.98	151.0	2.12	61.0	0.50	264.37
1.07	123.0	2.14	61.0	0.60	234.77
1.11	119.0	2.26	55.0	0.71	208.31
1.31	105.0	2.35	56.0	0.82	186.20
1.53	89.0	2.49	50.0	1.03	153.17
1.53	90.0	2.72	45.0	1.24	128.04
1.56	89.0	2.77	45.0	1.51	104.21
1.78	75.0	2.81	44.0	1.77	86.75
		3.08	40.0	2.14	69.10
				2.50	56.36
				3.50	38.04
				4.50	27.99

ADINAT PROBLEM 6.3 — BWIP

RADIAL TEMPERATURE PROFILE ON DAY 350



HORIZONTAL TEMPERATURE PROFILE (C)
AT 4.25m BELOW FLOOR AT DAY 350

X(m)	NODE	ADINAT	FIELD
0.20	332	435.78	
0.30	333	371.20	
0.40	334	323.91	
0.50	335	287.59	
0.60	336	257.96	262.00
0.71	337	231.33	232.00
0.82	338	209.05	207.00
1.03	339	175.22	
1.24	340	149.47	
1.51	341	124.31	
1.77	342	105.90	
2.03		92.16	84.00
2.14	343	86.35	
2.50	344	72.23	
3.02		59.98	48.00
3.50	345	48.67	
4.50	346	35.33	
6.00	347	25.94	
7.50	348	20.70	
9.25	349	18.20	
11.00	350	16.74	
13.00	351	16.22	
15.00	352	15.99	

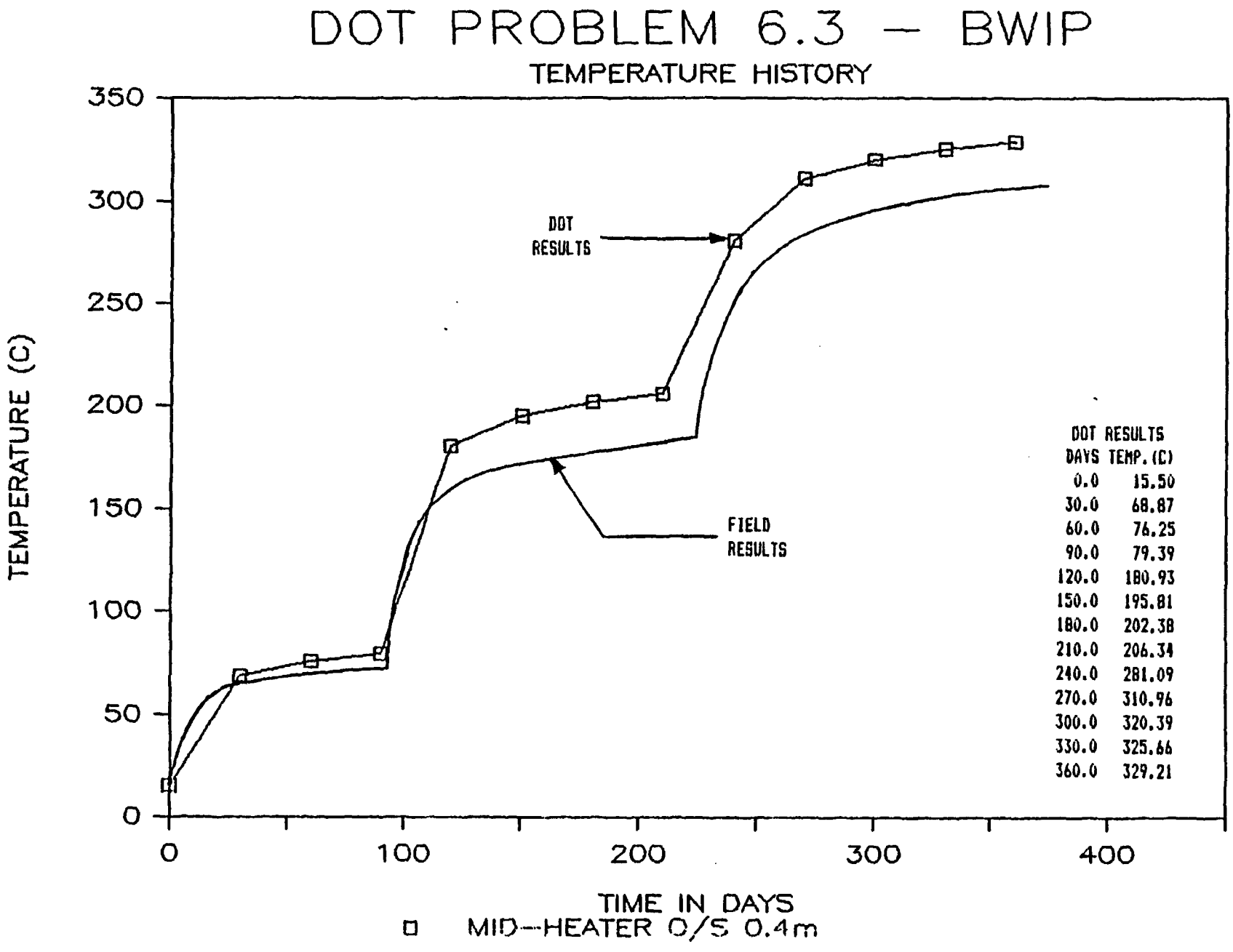
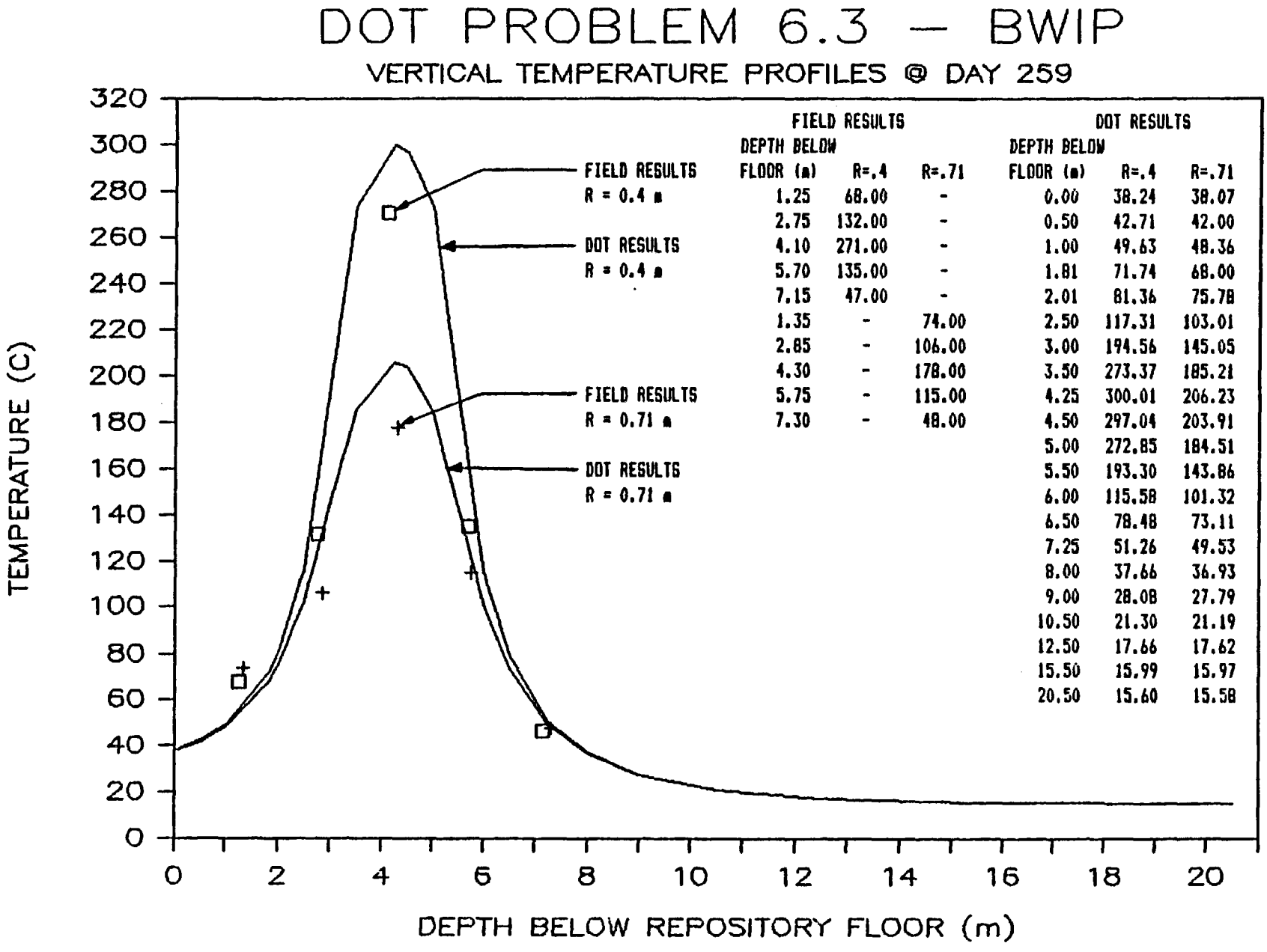


Figure 6.6 2 DOT Problem 6.3
Temperature History



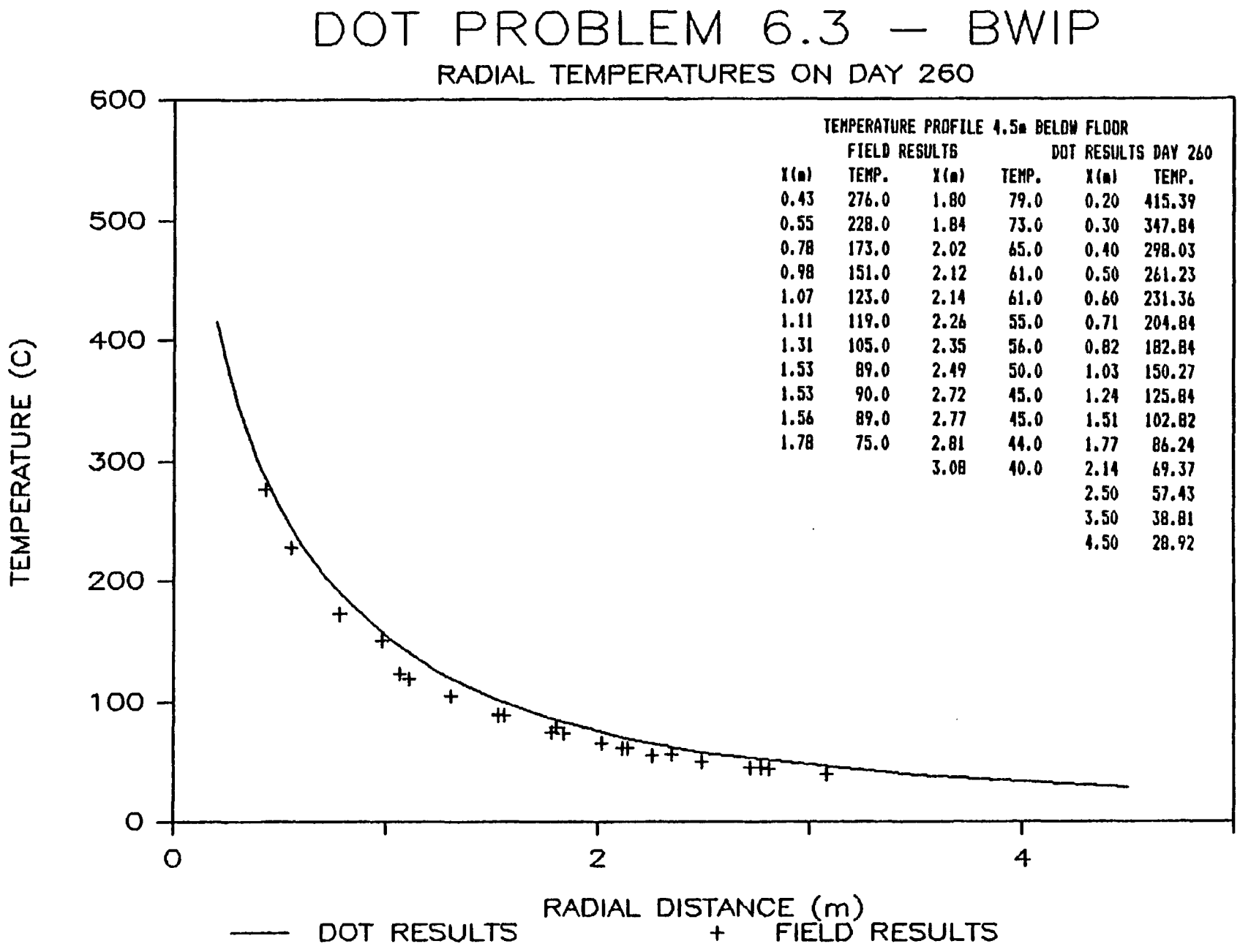
FIELD RESULTS

DEPTH BELOW FLOOR (m)	R=.4	R=.71
1.25	68.00	-
2.75	132.00	-
4.10	271.00	-
5.70	135.00	-
7.15	47.00	-
1.35	-	74.00
2.85	-	106.00
4.30	-	178.00
5.75	-	115.00
7.30	-	48.00

DOT RESULTS

DEPTH BELOW FLOOR (m)	R=.4	R=.71
0.00	38.24	38.07
0.50	42.71	42.00
1.00	49.63	48.36
1.81	71.74	68.00
2.01	81.36	75.78
2.50	117.31	103.01
3.00	194.56	145.05
3.50	273.37	185.21
4.25	300.01	206.23
4.50	297.04	203.91
5.00	272.85	184.51
5.50	193.30	143.86
6.00	115.58	101.32
6.50	78.48	73.11
7.25	51.26	49.53
8.00	37.66	36.93
9.00	28.08	27.79
10.50	21.30	21.19
12.50	17.66	17.62
15.50	15.99	15.97
20.50	15.60	15.58

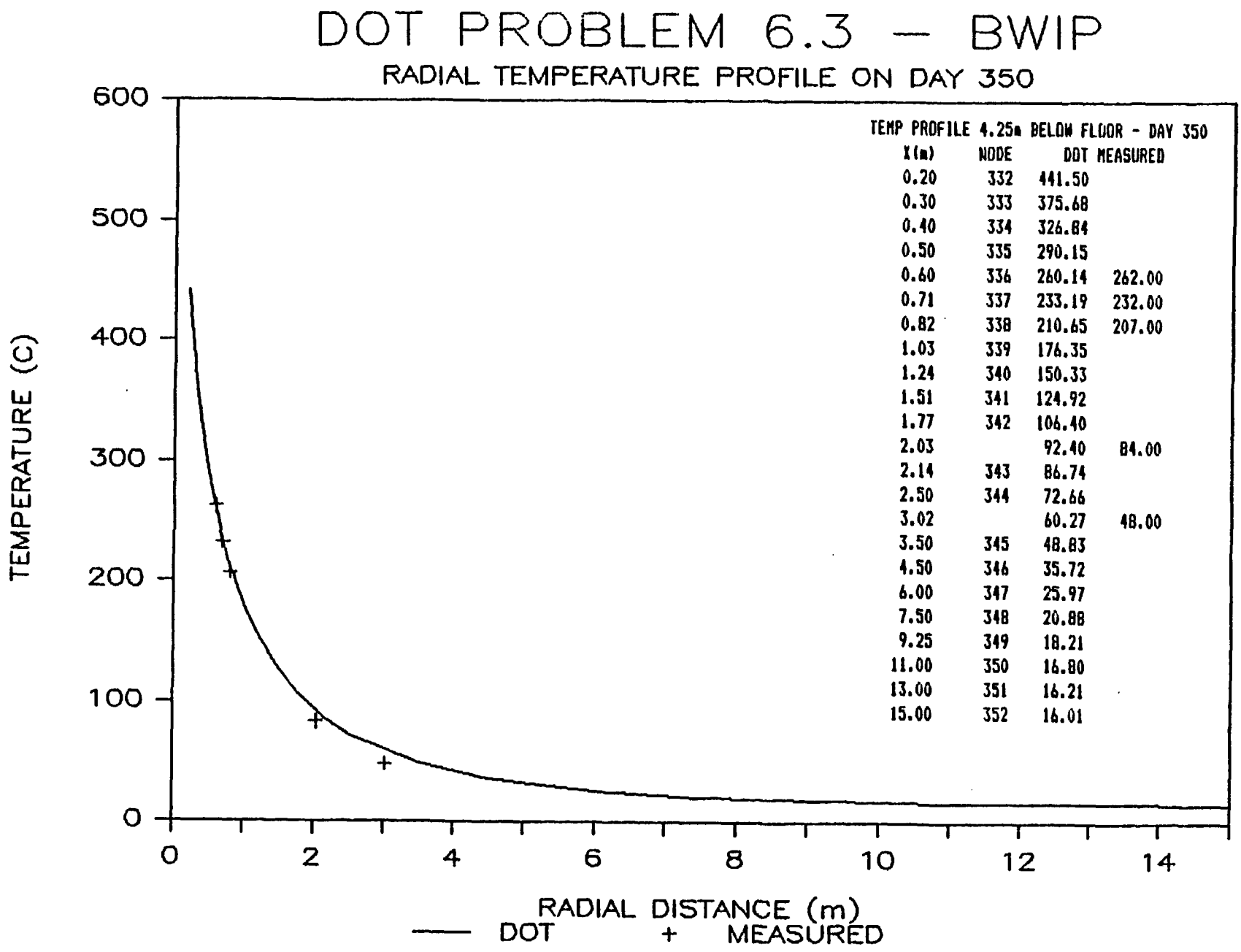
Figure 6.6-4 DOT Problem 6.3
Vertical Temperature Profiles
Day 259



TEMPERATURE PROFILE 4.5m BELOW FLOOR

FIELD RESULTS				DOT RESULTS DAY 260	
X(m)	TEMP.	X(m)	TEMP.	X(m)	TEMP.
0.43	276.0	1.80	79.0	0.20	415.39
0.55	228.0	1.84	73.0	0.30	347.84
0.78	173.0	2.02	65.0	0.40	298.03
0.98	151.0	2.12	61.0	0.50	261.23
1.07	123.0	2.14	61.0	0.60	231.36
1.11	119.0	2.26	55.0	0.71	204.84
1.31	105.0	2.35	56.0	0.82	182.84
1.53	89.0	2.49	50.0	1.03	150.27
1.53	90.0	2.72	45.0	1.24	125.84
1.56	89.0	2.77	45.0	1.51	102.82
1.78	75.0	2.81	44.0	1.77	86.24
		3.08	40.0	2.14	69.37
				2.50	57.43
				3.50	38.81
				4.50	28.92

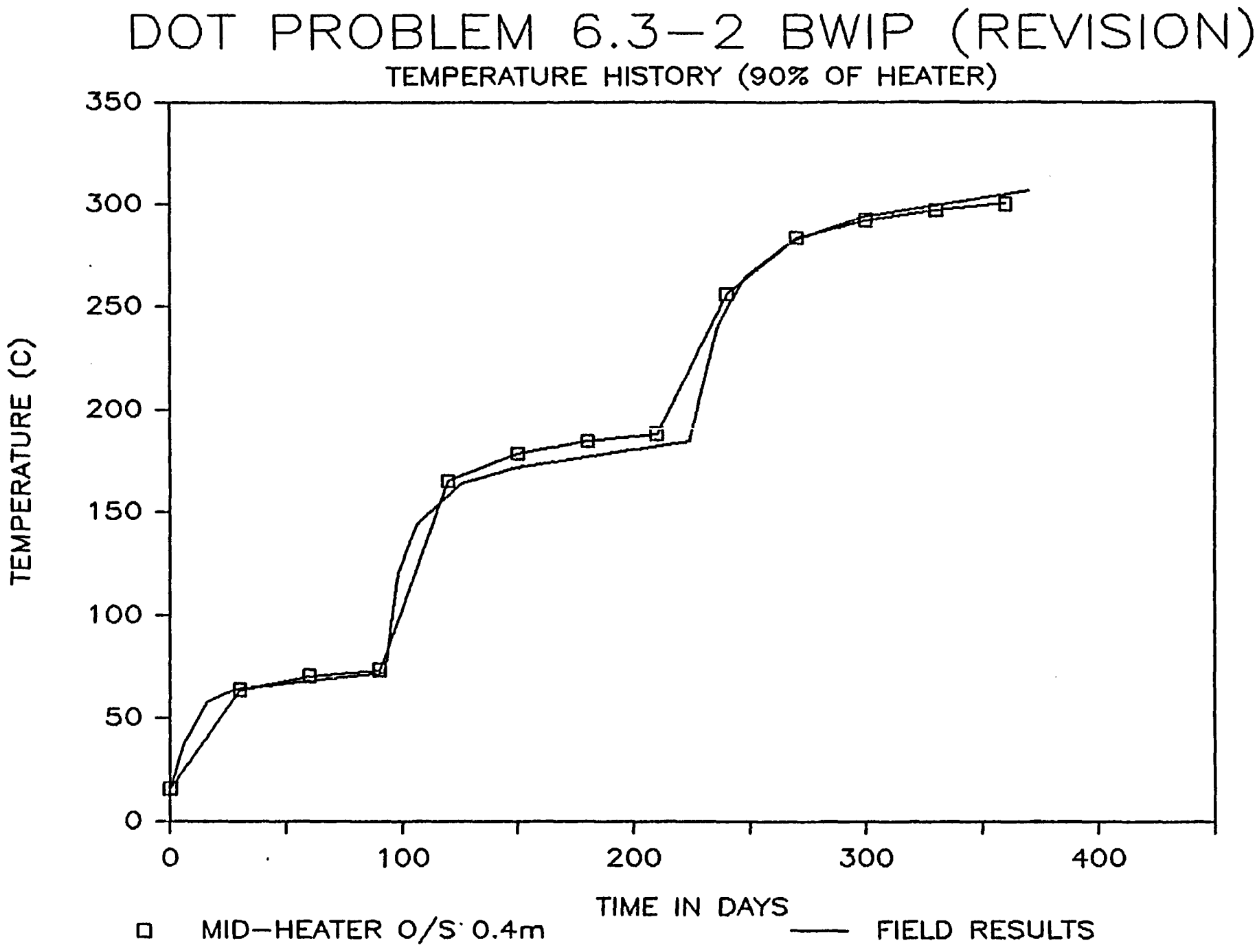
Figure 6.6-3 DOT Problem 6.3
Radial Temperature Distribution
on Day 260 at 4.5m Depth Below
Repository Floor



TEMP PROFILE 4.25m BELOW FLOOR - DAY 350

X(m)	NODE	DOT	MEASURED
0.20	332	441.50	
0.30	333	375.68	
0.40	334	326.84	
0.50	335	290.15	
0.60	336	260.14	262.00
0.71	337	233.19	232.00
0.82	338	210.65	207.00
1.03	339	176.35	
1.24	340	150.33	
1.51	341	124.92	
1.77	342	106.40	
2.03		92.40	84.00
2.14	343	86.74	
2.50	344	72.66	
3.02		60.27	48.00
3.50	345	48.83	
4.50	346	35.72	
6.00	347	25.97	
7.50	348	20.88	
9.25	349	18.21	
11.00	350	16.80	
13.00	351	16.21	
15.00	352	16.01	

Figure 6.6-5 DOT Problem 6.3 Radial Temperature Distribution on Day 350 at 4.25m Depth Below Repository Floor


DOT PROBLEM 6.3-2 BWIP (REVISION)
TEMPERATURE HISTORY (90% OF HEATER)
TEMPERATURE (C)
350
300
250
200
150
100
50
0
0
100
200
300
400
TIME IN DAYS
MID-HEATER O/S 0.4m
FIELD RESULTS