Structural Engineering Report No. 125

ANALYSIS OF FIELD MEASURED DEFLECTIONS
SCOTIA PLACE OFFICE COMPLEX
SOUTH TOWER

By

Andrew Scanlon

and

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INTRODUCTION

Contract documents for construction of the twin 28-story office towers of Scotia Place located in downtown Edmonton, Alberta included a requirement to monitor deflections of the concrete two-way slab floor system both during and after construction. As a result, a valuable data base was established to provide needed information on the response of floor systems to construction loads and long time sustained loads.

This report provides a summary of the data obtained from the deflection surveys of the south tower. In addition, results of a finite element analysis of the slab system are presented and compared with the measured data.

BUILDING DESCRIPTION

The complex consists of two towers, one 28 storey and one 20 storeys in height. Each tower has an identical L-shaped floor plan for floors 8 through 28 as shown in Fig. 1. The floor system consists of a 200 mm thick two-way flat slab with 150 mm drop panels and 1520 x 1520 mm column capitals. Columns are spaced at 9000 mm on center. Reinforcement details are given in Appendix A.

For purposes of this study the slab panels are categorized according to the boundary conditions along each side of the panel, and panel reinforcement details. Panel types designated A, B, C, D, and E are identified in Fig. 1. The triangular-

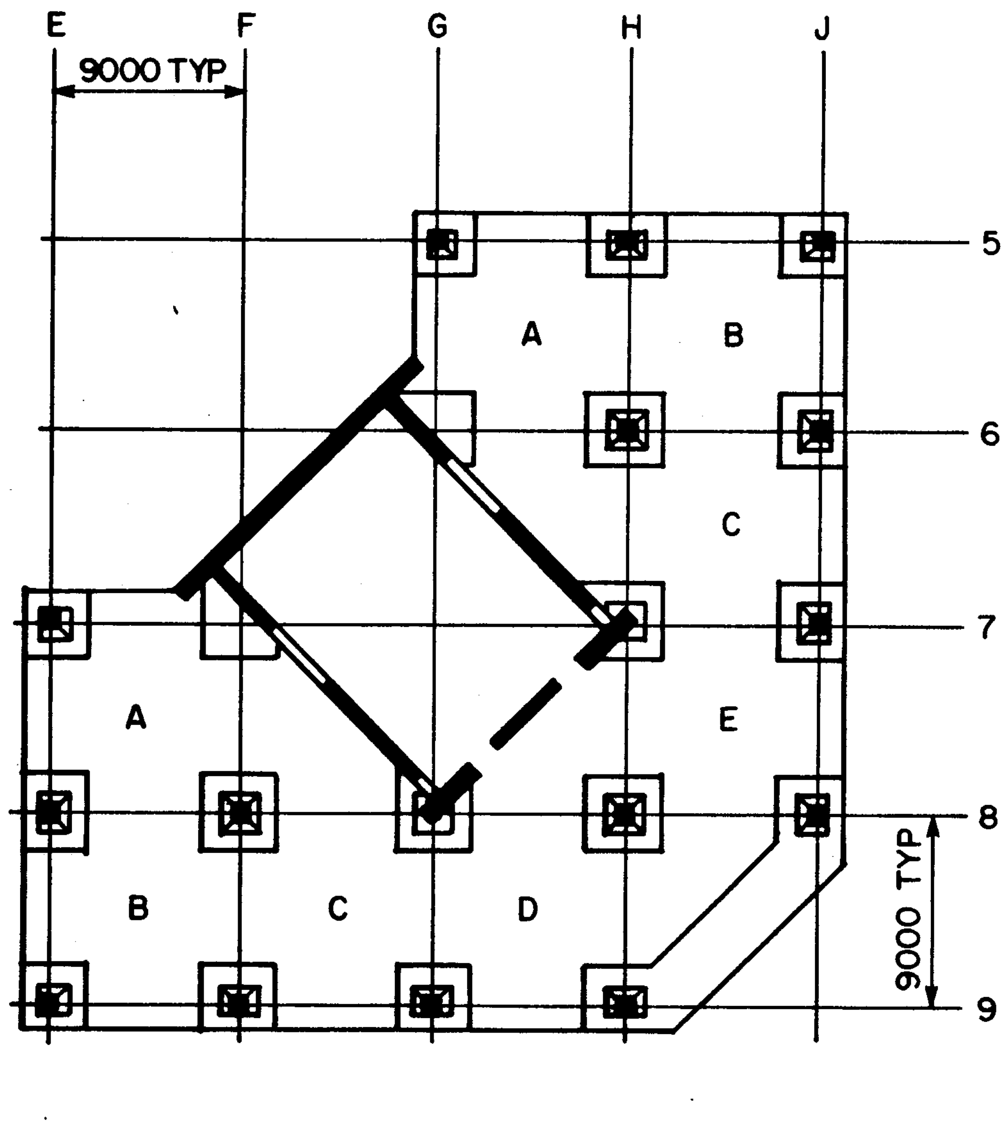


Fig. 1. Floor Plan - Levels 8 through 28

shaped panels were not included in the study.

CONSTRUCTION SCHEDULE

Construction of Floors 8 to 28 of the south tower took place between May 1981 and October 1981. The floors were constructed using a system of shoring and re-shoring. Floors were placed at a rate of approximately one per week. In general each floor was placed with 2 levels of shores and two levels of re-shores. The construction schedule is outlined in Appendix B.

CYLINDER COMPRESSIVE STRENGTH TESTS

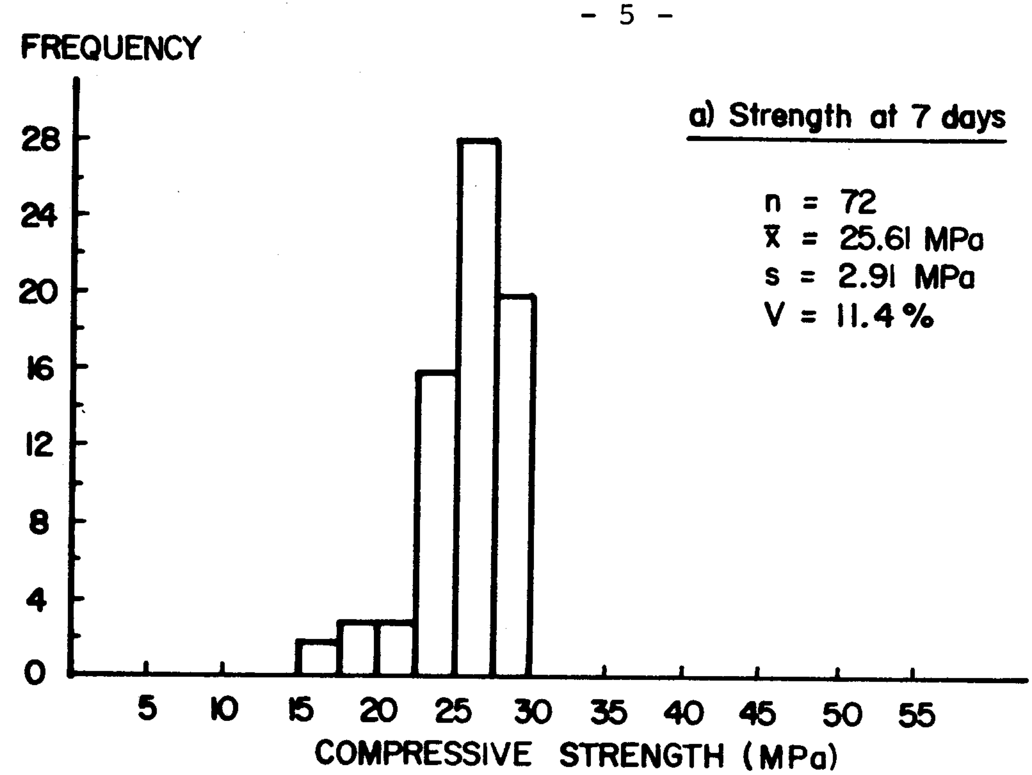
Specified 28-day cylinder compressive strength was 30 MPa for the floor slabs. For each floor a series of standard 100x300 mm cylinder compressive strength tests was made at

a) 2 to 5 days

b) 7 days

c) 28 days.

Compressive strengths obtained from job records are listed in Appendix C. The results for 7 and 28 days are summarized in Fig. 2 in the form of histograms. The mean strength at 28 days was 34.93 MPa with a coefficient of variation of 12.6 % and range of 96.0 MPa to 45.4 MPa.



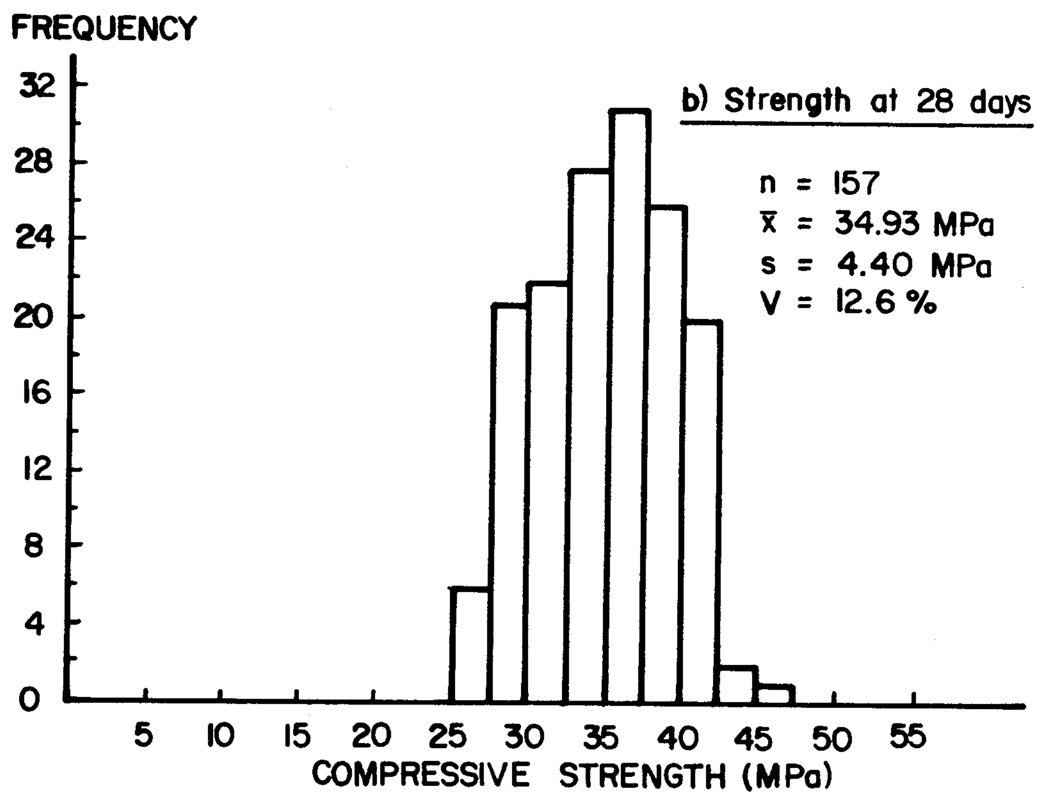


Fig. 2. Histograms of Cylinder Compressive Strengths at 7 and 28 Days

SLAB DEFLECTION MEASUREMENTS

Slab deflections were measured both during construction and at approximately one year after completion of construction. Measurements were made on each slab during the period in which it was subjected to loads from slabs above through the shores and re-shores.

Deflection measurements were made using standard level surveying techniques. A bench mark was established on each floor. Level readings were taken at mid-panel, at mid-span between columns, and adjacent to columns. Mid-panel and mid-column strip deflections were then established relative to the slab elevation at adjacent columns. Measurements were taken at each shored and re-shored level immediately after forms were stripped from the top slab.

Mid-panel slab deflections were obtained from the job records and are tabulated in Appendix D. Figures 3 and 4 show the deflection vs. time plots for panel types A and B respectively. Also included in the plot are the average measured deflections at each stage of construction and at one year after construction.

DEFLECTION STATISTICS

Slab deflection statistics at one year were developed from the tabulated measurements for the slabs of the south tower. These deflections were not all measured at precisely one year

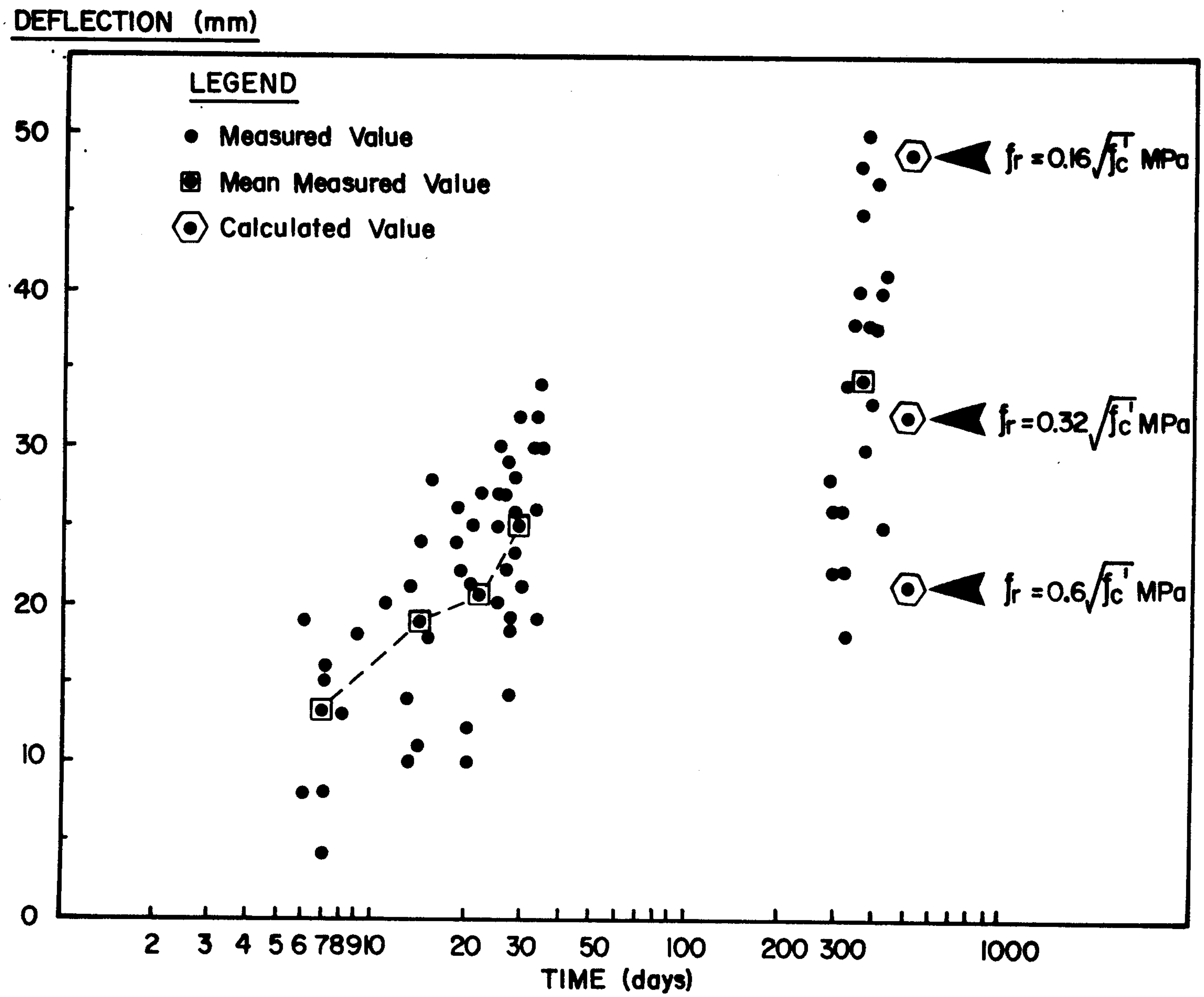


Fig. 3. Deflection vs. Time for Type A Slabs

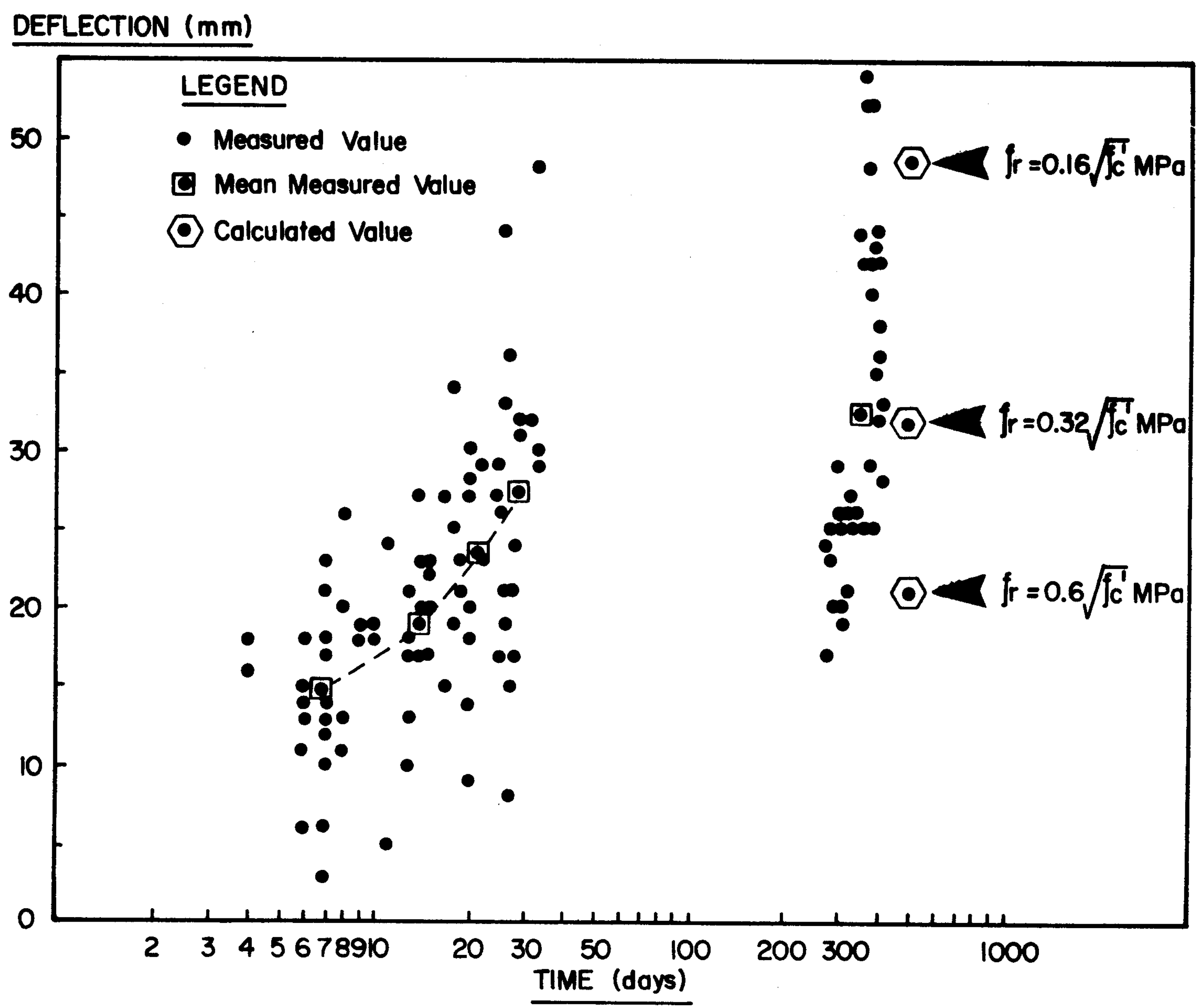


Fig. 4. Deflection vs. Time for Type B Slabs

after form removal. The "one-year deflections" actually represent measurements taken within the range of 278 days to 417 days. The plots shown in Figs. 5 though 9 illustrate that although there appears to be a slight tendency towards increase of deflection with time during the measurement period there is much more variation between individual slabs within the time period considered. It is therefore considered to be reasonable to lump all measurements together as one-year deflections. Histograms of measured one-year deflections are plotted in Figs. 10 through 12 for slabs A through E of the south tower. The statistics for these slabs are summarized in Table 1. The mean one-year deflection ranges from 32.53 to 39.05 mm while the coefficient of variation ranges from 24.8 to 31%.

FINITE ELEMENT ANALYSIS

Deflections were computed for a typical corner panel using a version of the general purpose computer program SAPIV[1], modified to incorporate effects of cracking.[2] Effects of construction loading and time dependent effects were included using the following procedure suggested by Graham and Scanlon[2].

(1) Calculate the maximum deflection, Δ_{max}, due to construction load. The applied load is calculated from:

$$w = (2)(w_D)(1.1) + \text{construction live load}$$
$$= 2(4.709)(1.1) + 2.4/4$$
$$= 10.97 \text{ kPa}$$

Table 1 Statistics of One-Year Slab Deflections for the South Tower

Slab Type	A	B	C	D	E
No. of Data Points	20	40	41	21	20
Mean Deflection (mm)	34.45	32.53	35.24	33.43	39.05
Standard Deviation	9.50	9.72	8.76	10.58	10.34
Coeff. of Variation	27.6	29.9	24.8	31.7	26.5
Range (mm)	32	35	40	36	52

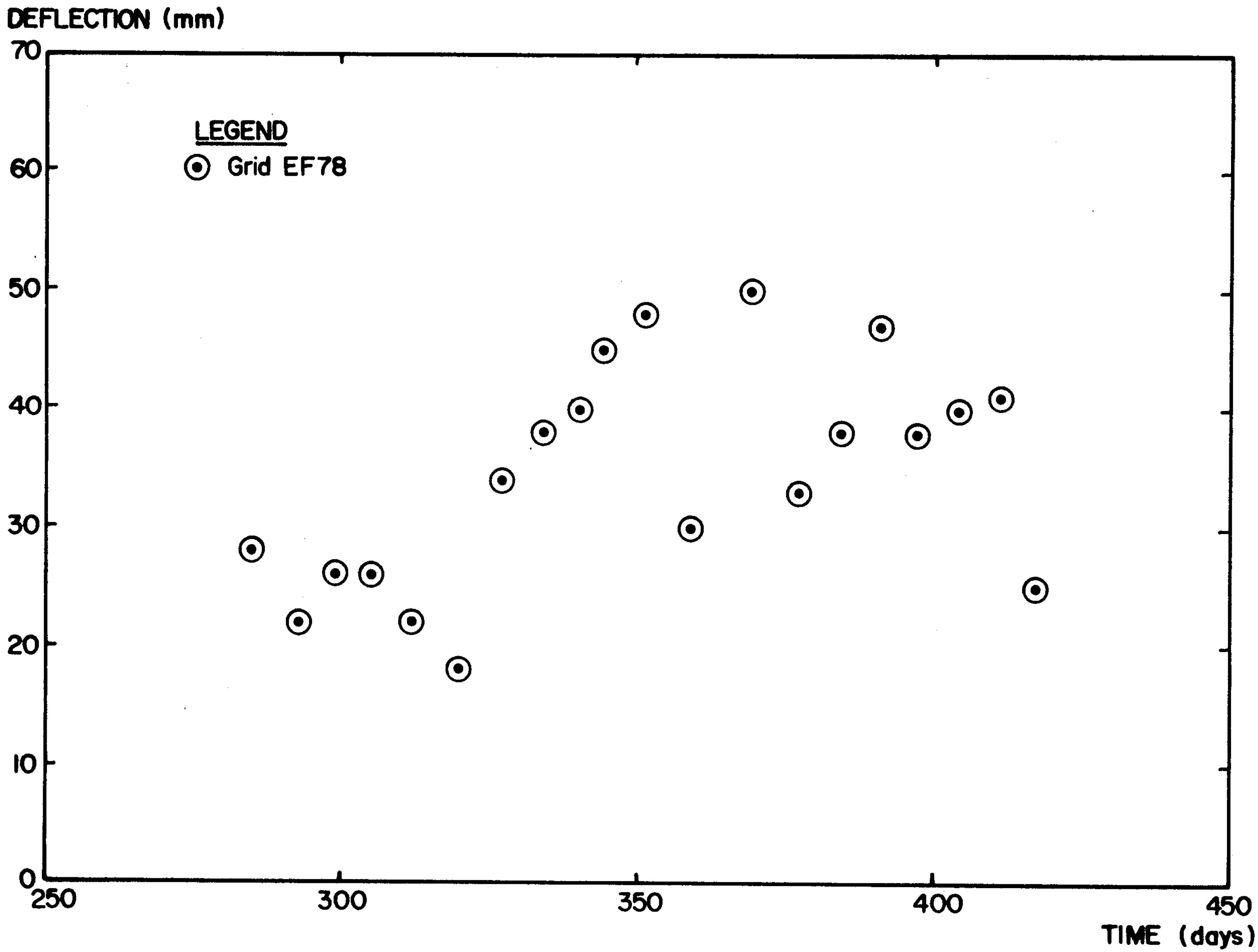


Fig. 5. Measured Deflections at Approximately One Year (Type A Slabs)

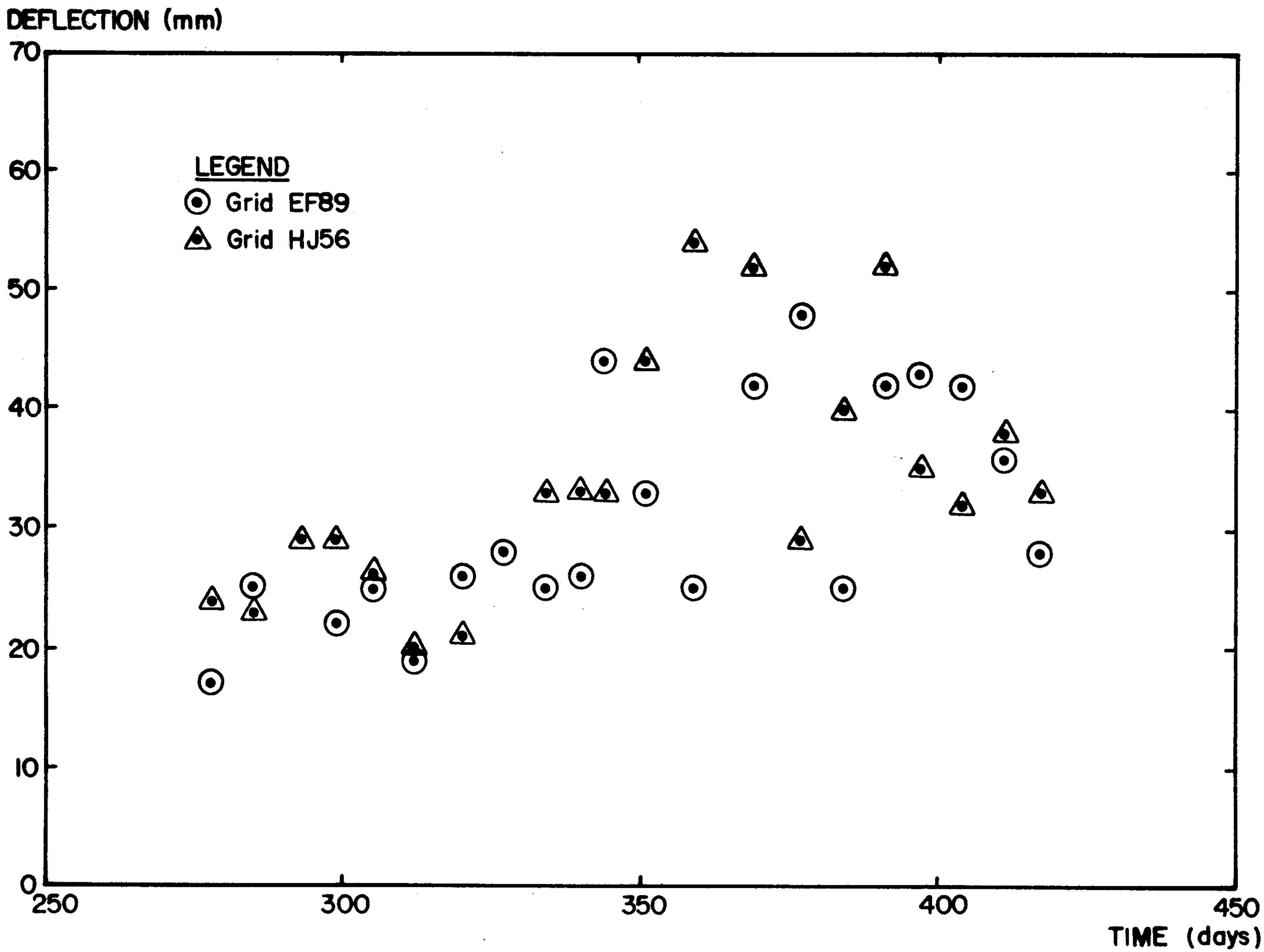


Fig. 6. Measured Deflections at Approximately One Year (Type B Slabs)

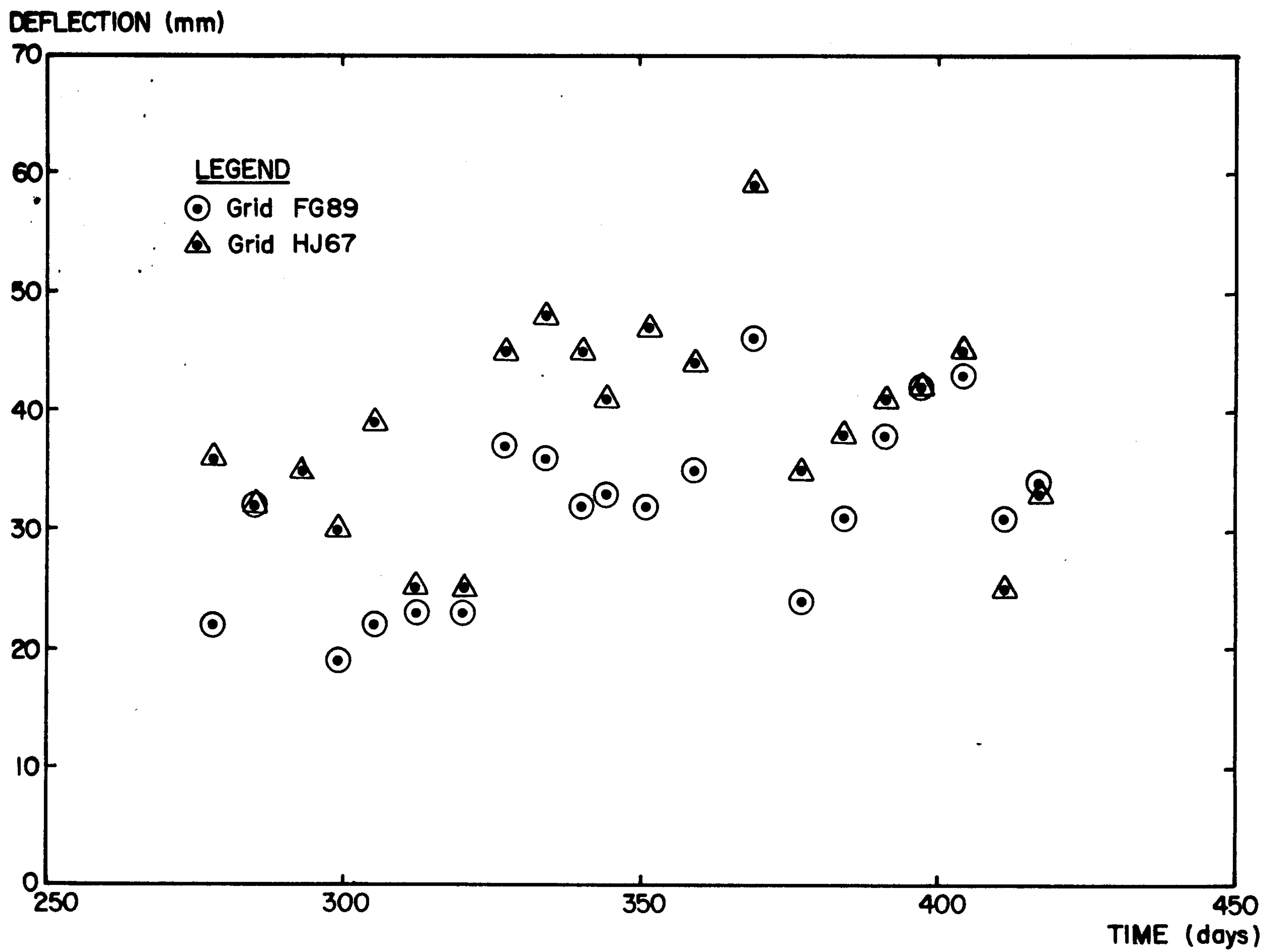


Fig. 7. Measured Deflections at Approximately One Year (Type C Slabs)

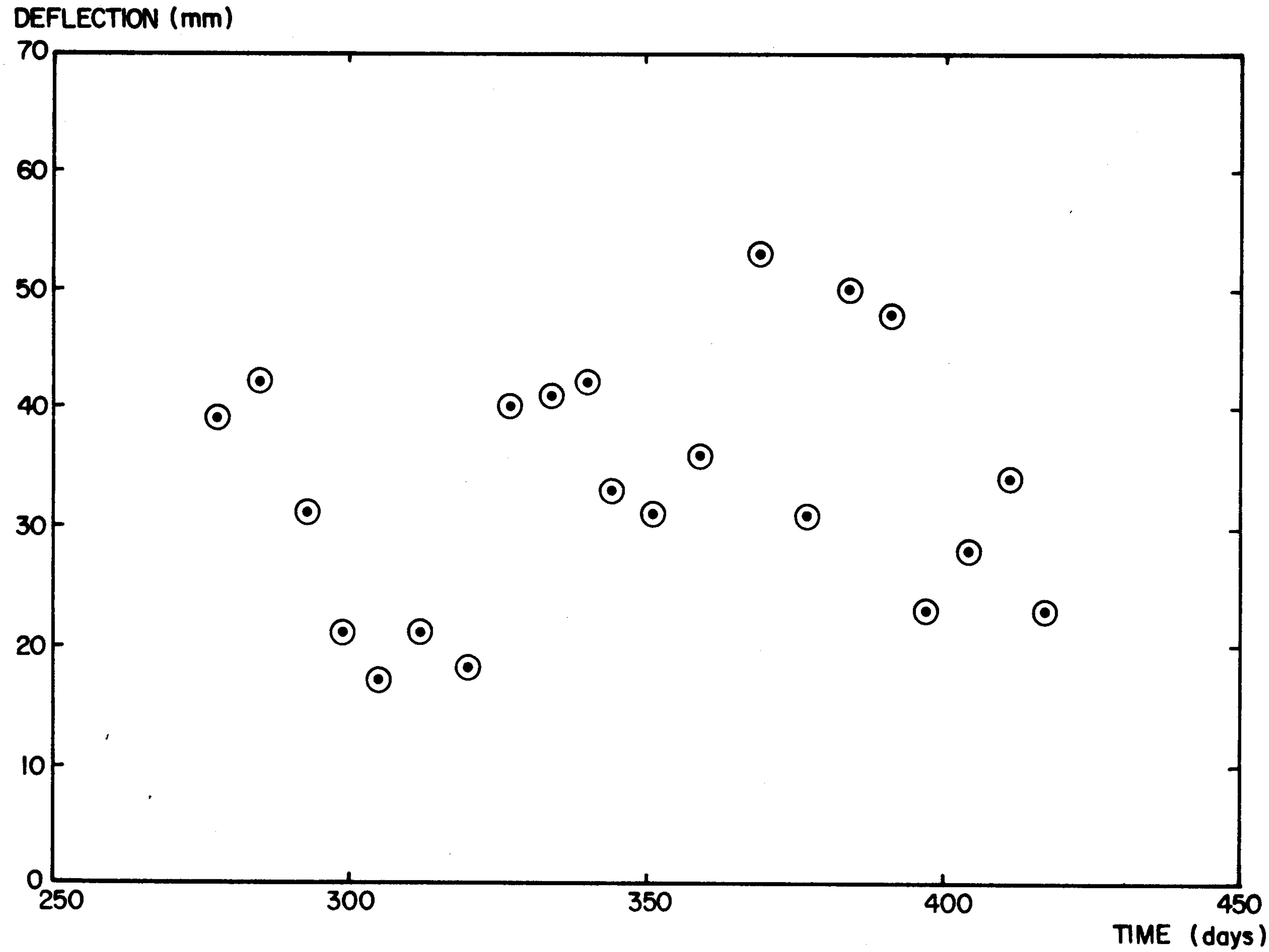


Fig. 8. Measured Deflections at Approximately One Year (Type D Slabs)

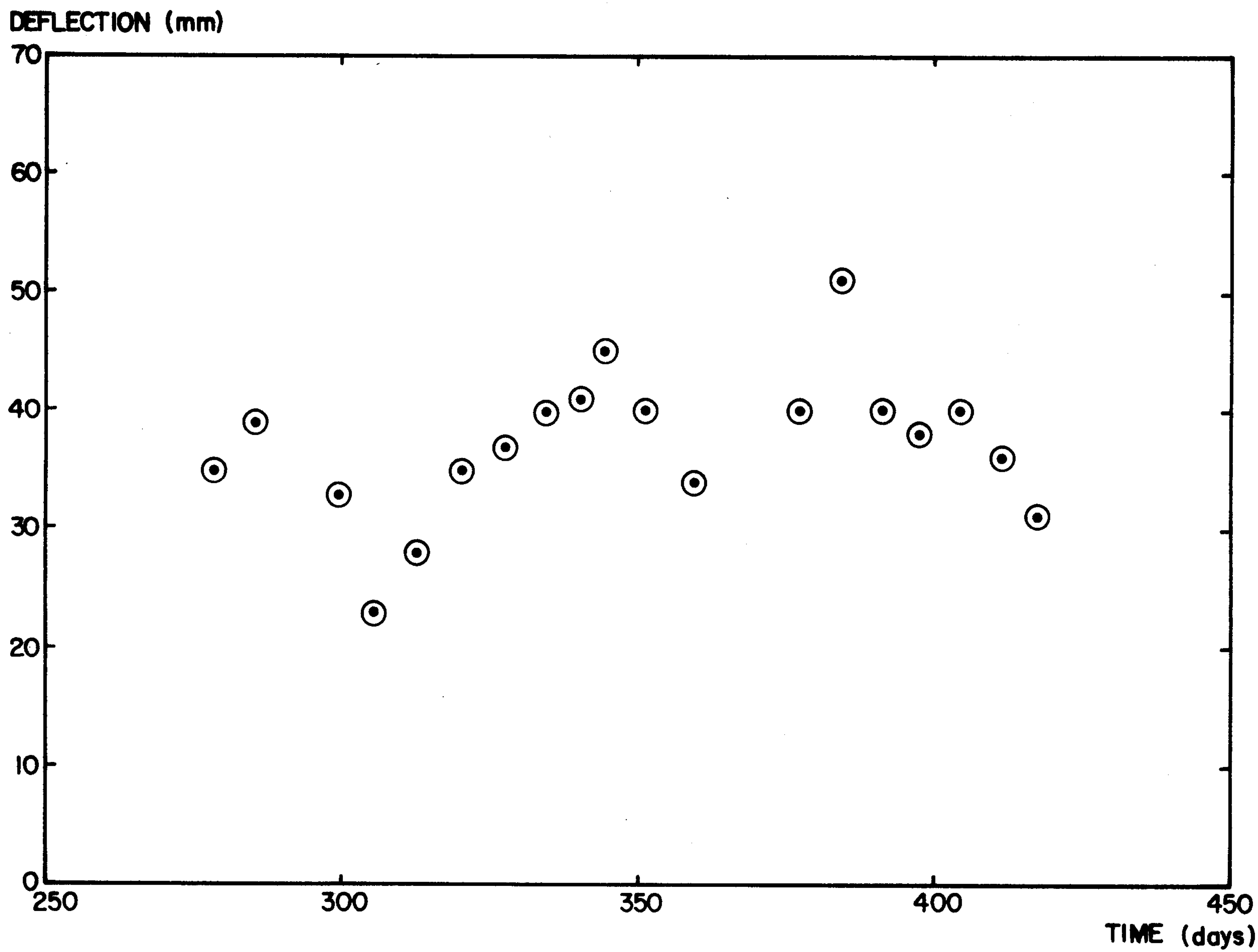
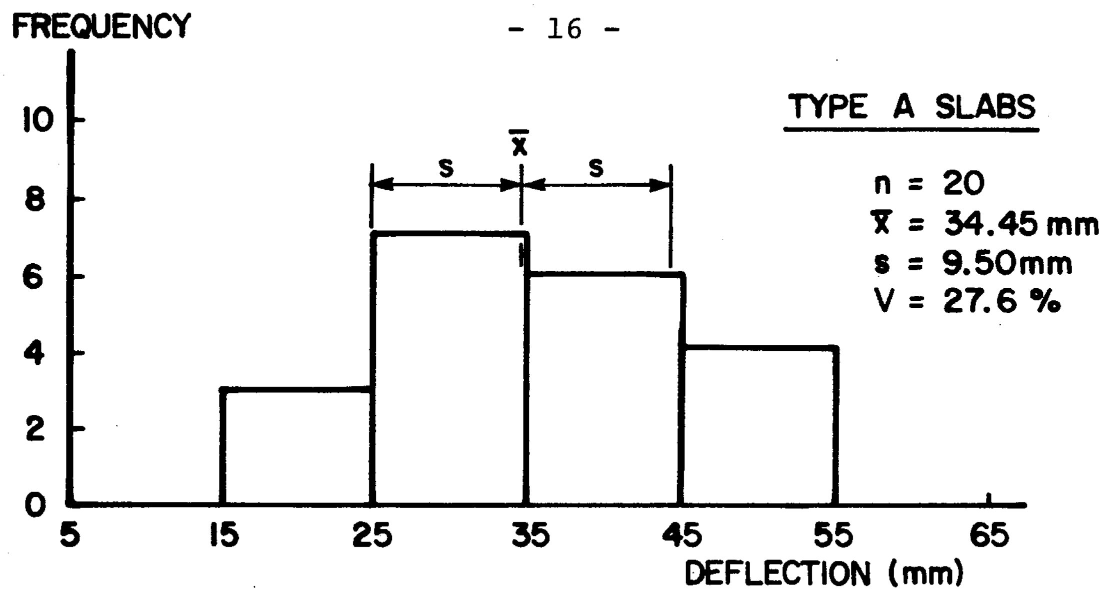
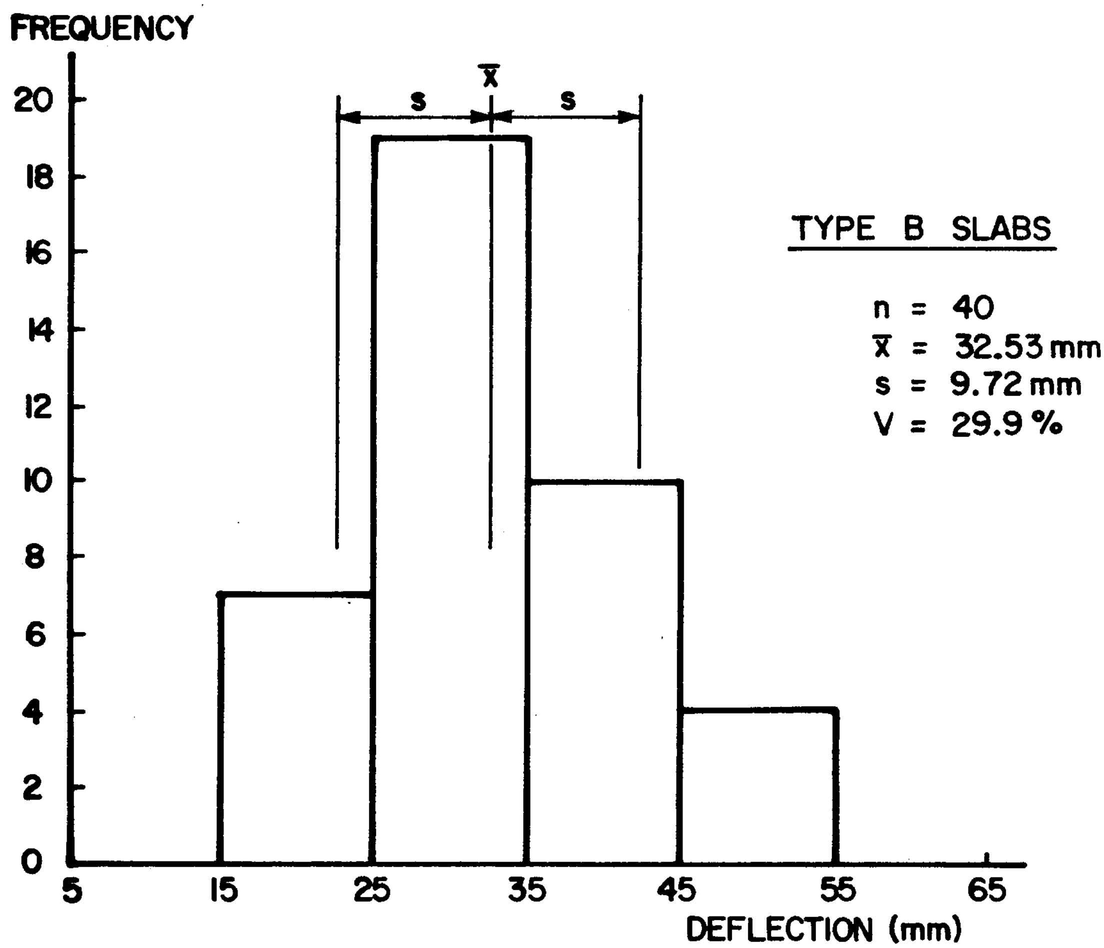


Fig. 9. Measured Deflections at Approximately One Year (Type E Slabs)

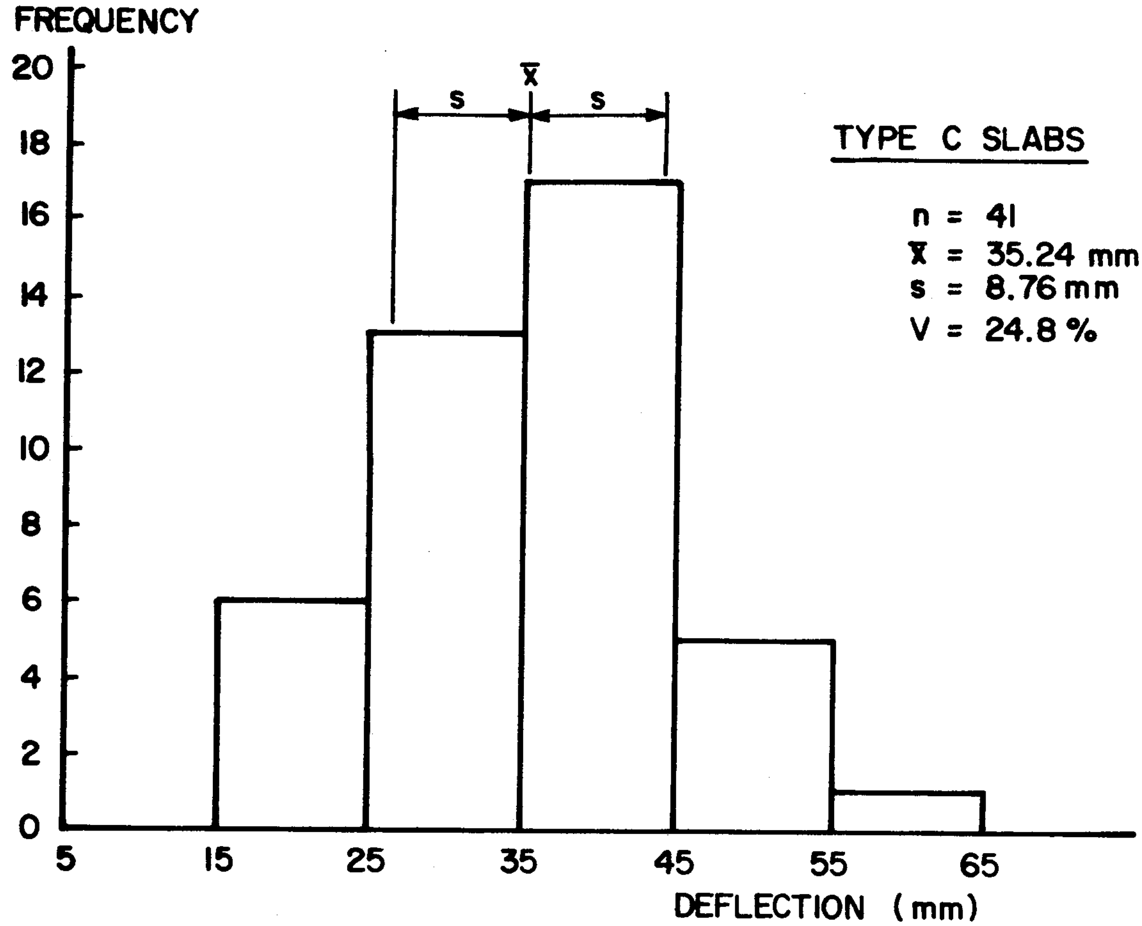


a) Type A Slabs

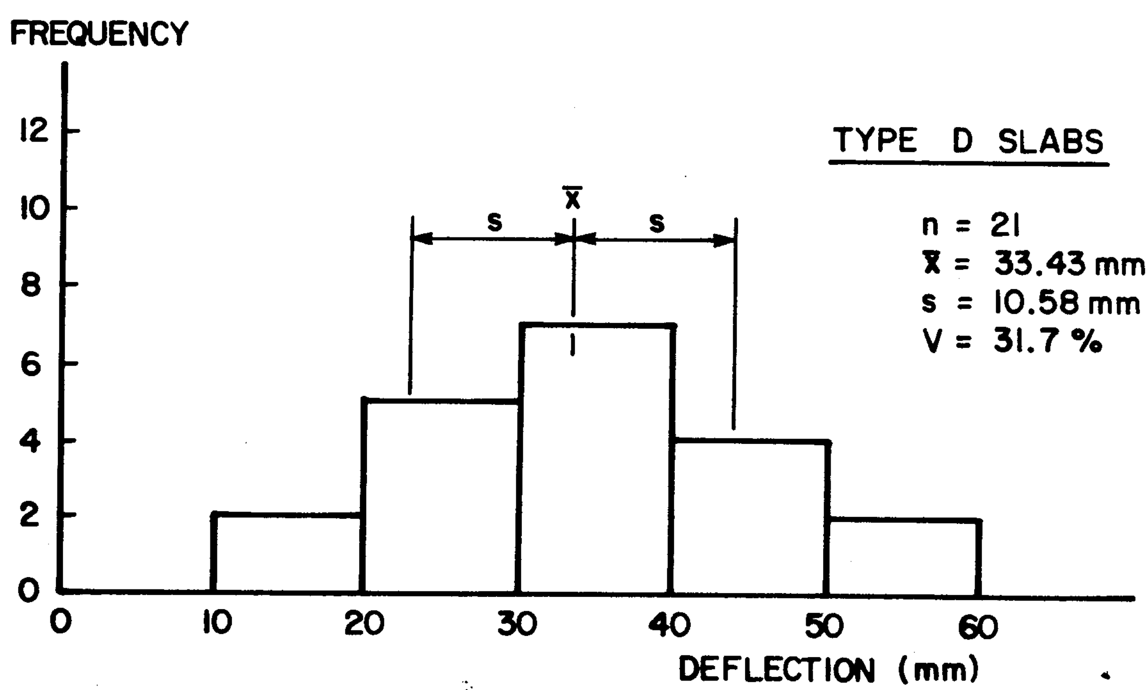


b) Type B Slabs

Fig. 10. Histograms of Measured One-Year Deflections (Type A and B Slabs)



a) Type C Slabs



b) Type D Slabs

Fig. 11. Histograms of Measured One-Year Deflections (Type C and D Slabs)

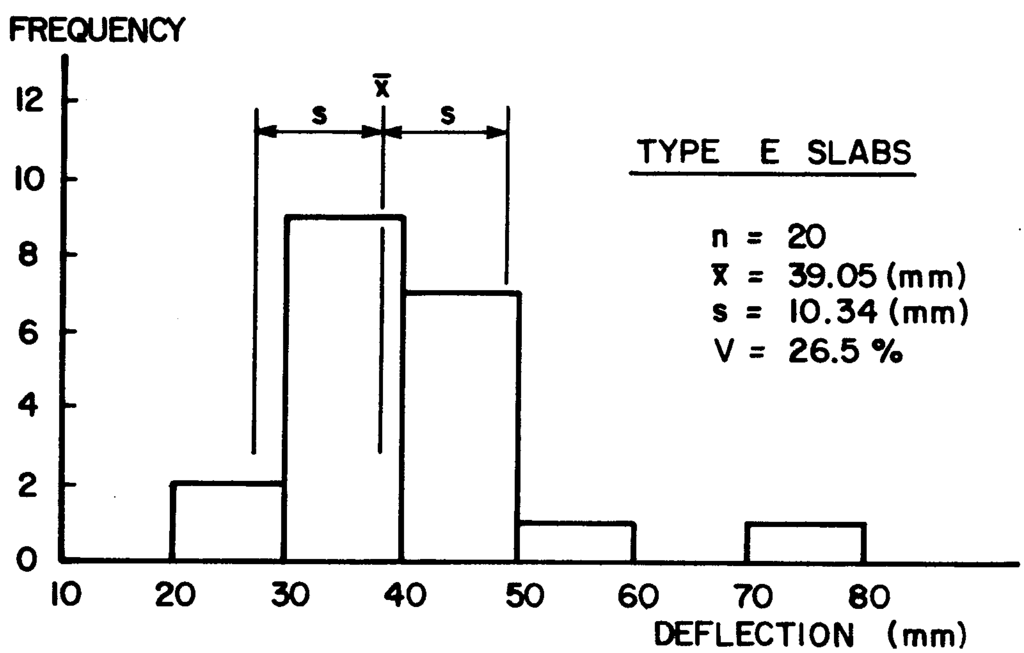


Fig. 12. Histogram of Measured One-Year Deflections (Type E Slabs)

Cracking is accounted for in the analysis using Branson's effective moment of inertia. The modulus of rupture must be specified. In this study, three values were considered.

a) $f_r = 7.5\sqrt{f'_c}$ psi $(0.6\sqrt{f'_c}$ MPa)

b) $f_r = 4\sqrt{f'_c}$ psi $(0.32\sqrt{f'_c}$ MPa)

c) $f_r = 2\sqrt{f'_c}$ psi $(0.16\sqrt{f'_c}$ MPa)

Case a) represents the value specified in the ACI Code[3]. Cases b) and c) are reduced effective values to account for additional cracking due to restraint of shrinkage.[2,4]

(2) The maximum deflection, Δ_{max}, is scaled to the sustained load level, assumed in this study to be dead load + 20% live load, to obtain the immediate deflection due to sustained load,

$$\Delta_{SL} = \Delta_{max} \frac{\text{sustained load}}{\text{maximum load during construction}}$$

(3) Deflection at one-year is multiplied by a long-time multiplier, as recommended in Ref. 2. The long time multiplier depends on the value assumed for modulus of rupture. Graham and Scanlon recommended a multiplier of 4.25 for $f_r = 7.5\sqrt{f'_c}$ psi $(0.6\sqrt{f'_c}$ MPa), and a multiplier of 3.00 for $f_r = 4\sqrt{f'_c}$ psi $(0.32\sqrt{f'_c}$ MPa). No value was suggested for $f_r = 2\sqrt{f'_c}$ $(0.16\sqrt{f'_c}$ Mpa). For this last case a multiplier of 2.75 was selected. The variation in value of multiplier occurs because both creep and shrinkage warping effects are lumped together. While the total shrinkage warping deflection is assumed to be independent of degree of cracking, immediate + creep deflection is signficantly affected by the degree of cracking.[2]

Calculated deflections are summarized in Table 2 and superimposed on the deflection-time plots for panel types A and B shown in Figs. 3 and 4. It can be seen that the calculated deflections corresponding to $4\sqrt{f'_c}$ psi ($0.32\sqrt{f'_c}$ MPa) modulus of rupture are close to the mean values, while the calculated values for $7.5\sqrt{f'_c}$ ($0.6\sqrt{f'_c}$) and $2\sqrt{f'_c}$ ($0.16\sqrt{f'_c}$) psi (MPa) are closely related to the lower and upper ranges of measured deflection respectively.

SUMMARY AND CONCLUSIONS

This report presents results of a survey of field measured deflections for a 28-story office tower. Mean deflections at approximately one year after construction ranged from 32.5 to 39.1 mm with coefficients of variation ranging from 24.8 to 31.5%

Calculated deflections based on a finite element analysis provided good estimates of the range of deflections for a typical slab panel, depending on the modulus of rupture assumed in the analysis.

ACKNOWLEDGEMENTS

Data on field measured deflections as well as access to structural design drawings and specifications were provided by Quinn, Dressel, Jokinen Associates, consulting structural engineers for the project. Funding for the analysis of the survey data was provided by the Province of Alberta Summer

Table 2 Calculated Deflections

	Δ_{max} (mm)	Δ_{SL} (mm)	Δ (one year) (mm)
$f_r = 7.5\sqrt{f'_c}$ psi	10.2	5.0	21.1
$f_r = 4\sqrt{f'_c}$ psi	21.9	10.7	32.0
$f_r = 2\sqrt{f'_c}$ psi	36.2	17.5	48.4

Temporary Employment Program (STEP) and by the Natural Sciences and Engineering Research Council (NSERC) through Operating Grant A5153.

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1. Bathe, K.J., Wilson, E.L., and Peterson, F.E., "SAPIV - A Structural Analysis Program for Static and Dynamic Response of Linear Systems", Univ. of California, Berkeley, 1974, 59 pp.

2. Graham, C.J., and Scanlon, A., "Deflection of Reinforced Concrete Slabs under Construction Loading", Structural Engineering Report No. 117, University of Alberta, Canada, August 1984, 201 pp.

3. ACI Committee 318, "Building Code Requirements for Reinforced Concrete (ACI 318-83)", American Concrete Institute, Detroit, 1983, 111 pp.

4. Tam, K.S.S., and Scanlon, A., "The Effects of Restrained Shrinkage on Concrete Slabs", Structural Engineering Report No. 122, University of Alberta, Canada, December 1984, 126 pp.

APPENDIX A

REINFORCEMENT DETAILS

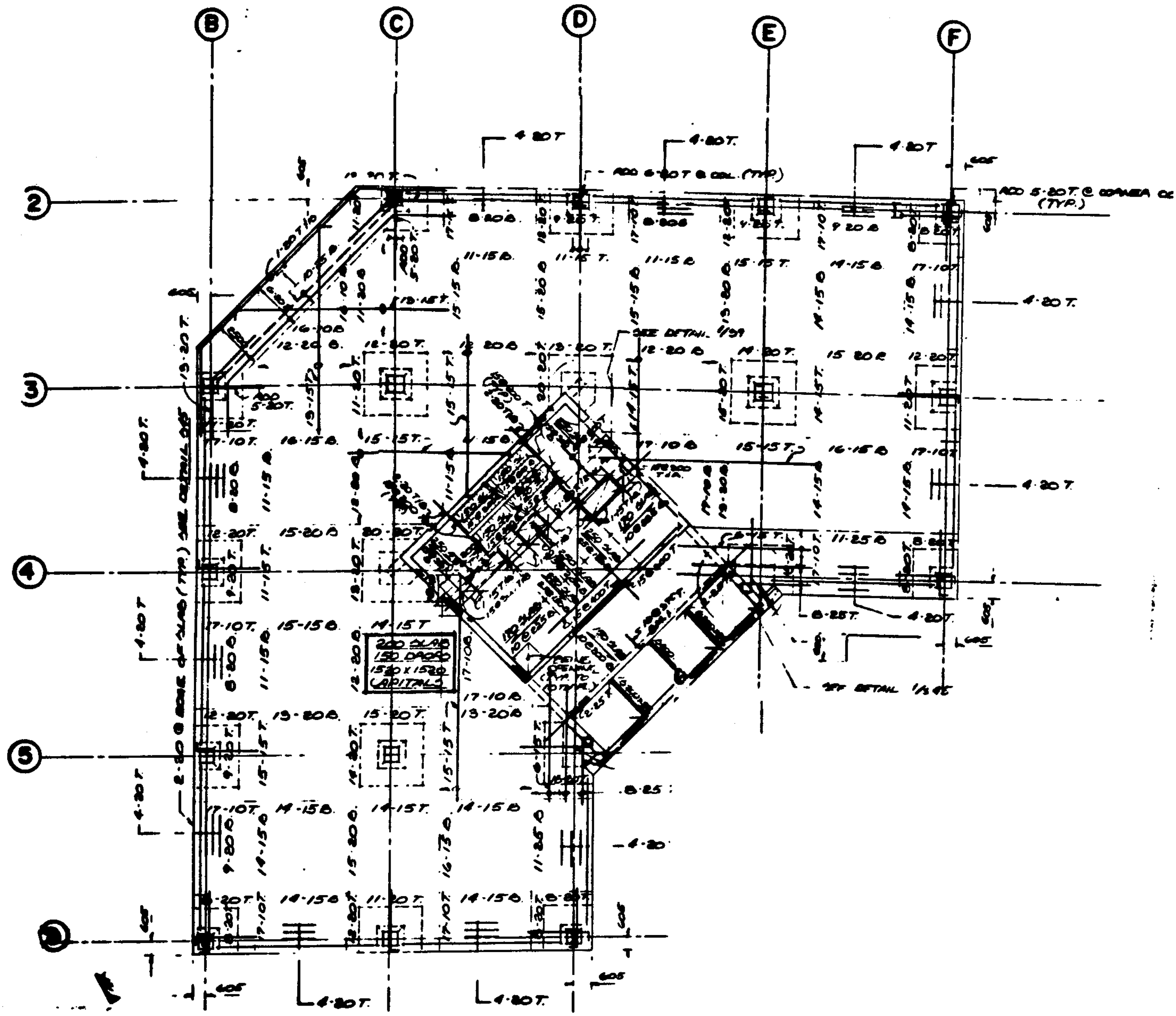

Fig. A1 - Reinforcement Details

APPENDIX B

CONSTRUCTION SCHEDULE

Construction Schedule: South Tower

Floor Number	Date Concrete Placed
Main	March 21, 1981
2	March 31, 1981
3	April 15, 1981
4	May 1, 1981
5	May 9, 1981
6	May 15, 1981
7	May 22, 1981
8	May 30, 1981
9	June 5, 1981
10	June 12, 1981
11	June 19, 1981
12	June 25, 1981
13	July 2, 1981
14	July 9, 1981
15	July 17, 1981
16	July 17, 1981
17	August 4, 1981
18	August 11, 1981
19	August 15, 1981
20	August 21, 1981
21	August 28, 1981
22	September 4, 1981
23	September 12, 1981
24	September 19, 1981
25	September 25, 1981
26	October 1, 1981
27	October 9, 1981
28	October 16, 1981

APPENDIX C

COMPRESSIVE STRENGTH TEST RESULTS

Table C1 Compressive Strength Test Results, Scotia Place, South Tower

Floor Number	2	3	4	5	7	28	Remarks
8	18.7	20.8			26.9	36.7	2 days initial cure
					26.8	39.2	
					28.8	38.2	
					28.6	39.8	
						39.9	water added after samples taken
						39.4	
						40.2	
						38.8	
9		17.9	20.6		26.3	40.3	
					27.1	40.6	
					27.9	38.4	
					26.1	(34.5)	(Cap Failure)
						40.2	
						41.5	
						42.9	
						39.7	
10		18.9	23.0		28.0	41.7	
					29.3	40.7	
					25.2	42.0	
					28.5	42.3	
						41.8	
						40.3	
						39.0	
						39.0	
11		19.6	23.9		29.4	40.3	
					29.3	39.7	
					27.7	36.9	
					26.6	38.4	
						36.4	
						38.8	
						37.8	
						37.7	
12	15.9		21.1		23.0	29.3	
					26.0	27.2	
					25.7	33.2	
					22.9	32.5	
						33.2	
						31.5	
						30.8	
						31.0	

Continued....

Table C1 continued

Floor Number	Age at Testing (Days) 2	3	4	5	7	28	Remarks
			19.8	22.6	25.0	31.5	
					24.7	31.4	
					22.5	29.9	
13					26.0	30.2	
						31.3	
						29.5	
						34.6	
						32.8	
			14.8		17.2	28.9	
					19.5	28.8	
					16.9	29.5	
14					18.4	31.4	
						29.8	
						29.7	
						30.4	
						33.5	
		13.5	15.1	16.9	18.1	27.8	
				17.0	20.6	26.6	
						28.0	
15						27.9	
						26.0	
						26.3	
						27.5	
						29.4	
	17.5	20.6			26.5	34.8	
		21.0				34.0	
16		20.8					
		19.3					
		20.6					
	13.1	20.6	21.8		26.1	33.9	
	15.8	26.3			29.7	33.7	
	21.2					32.0	
	24.0					36.5	
17	16.5					35.4	
						31.6	
						31.4	
						39.0	
						38.2	

Continued ...

Table C1 continued

Floor	Age at Testing (Days)						Remarks
Number	2	3	4	5	7	28	
18		23.1	24.7		27.0	35.2	
		24.1	25.2		25.3	34.8	
					25.9	34.8	
					24.9	31.9	
						32.8	
						33.8	
						35.1	
						35.4	
19	19.8	18.9	21.7		23.6	29.3	
			22.0		23.8	29.8	
					22.0	28.9	
					23.8	29.5	2 days initial
						27.4	cure
						26.9	
						29.7	
						31.5	
20		17.4	19.2		21.9	30.1	
					23.5	28.7	
					24.7	30.2	
						29.9	
						28.0	
						30.9	
						32.1	
21		16.7	19.2		24.8	33.6	
					24.2	33.2	
					25.7	32.3	(34.0 @ 35
						32.1	days)
						34.8	
						34.3	
22		17.9	24.3	24.1	27.9	38.2	
					28.5	38.0	
					28.3	36.8	
					29.5	35.0	
						36.4	
						35.3	
						38.5	
						36.3	

Continued ...

Table C1 continued

Floor Number	Age at Testing (Days) 2	3	4	5	7	28	Remarks
23		16.0	19.7	22.5	24.1	35.0	2 days initial cure
		17.8			28.1	36.5	
					28.7	37.1	
						37.4	
						37.4	
						40.3	
						40.8	
						41.0	
24	13.3	16.8	21.1		25.4	35.2	2 days initial cure
		19.6			26.2	34.5	
					24.6	35.5	
						33.2	
						32.6	
						31.4	
						33.3	
						32.8	
25		16.4	19.4	22.5	25.4	39.9	
					27.3	39.7	
					27.0	40.6	
					28.2	40.8	
						39.8	
						42.5	
						45.4	
						44.6	
26		19.4	22.4	23.6	26.9	34.9	
					25.5	37.6	
					27.2	35.7	
					26.4	35.1	
						37.3	
						37.8	
						37.4	
						36.4	
27		16.0	18.1		23.7	36.7	
					29.3	35.1	
					24.9	40.7	
					27.0	41.3	
						35.4	
						33.7	
						35.9	
						37.7	

Continued ...

Table C1 continued

Floor Number	Age at Testing (Days) 2	3	4	5	7	28	Remarks
28		16.2	22.0	25.3	28.2 26.8 26.5	39.3 37.8 31.0 33.6 31.3 32.4	
No. of Values					72	157	
Mean					25.61	34.93	
Standard Deviation					2.91	4.40	
Coeff. of Variation					11.4%	12.6%	
Range:							
From					16.9	26.0	
To					29.7	45.4	

APPENDIX D

MID-PANEL DEFLECTION MEASUREMENTS

Table D1 Mid-Panel Deflections - Slab Type A

Floor	Grid	Time Since Form Removal and Corresponding Measured Deflection															
		Forms Removed		Load From 1 Floor		Load From 2 Floors		Load From 3 Floors		Load From 4 Floors		Shores Removed		April/82		July/82	
		t_1 (days)	Δ_1 (mm)	t_2 (days)	Δ_2 (mm)	t_3 (days)	Δ_3 (mm)	t_4 (days)	Δ_4 (mm)	t_5 (days)	Δ_5 (mm)	t_6 (days)	Δ_6 (mm)	t_7 (days)	Δ_7 (mm)	t_8 (days)	Δ_8 (mm)
8	EF78		11	6	19	13	21	20	25	26	27		22			417	25
9	EF78			7	4	14	11	20	12	27	19		28			411	41
10	EF78		-1	7	8	13	10	20	10	27	14		19	306	31	404	40
11	EF78		8	6	8	13	14	20	21	28	26		23			397	38
12	EF78		15	7	16	14	24	22	27	32	30		32			391	47
13	EF78		7	7	15	15	28	25	24	33	19		30			384	38
14	EF78		6	8	13	18	26	26	29	33	34		26			377	33
15	EF78		13	9	18	18	24	25	30	29	32		25			369	50
16	EF78			8	13	15	18	19	22	25	25		20			359	30
17	EF78		10	7	16	11	20	17	6				21			351	48
18	EF78			4	13	10	14						25	246	54	344	45
19	EF78			6	15								21			340	40
20	EF78			7	14								23			334	38
21	EF78															327	34
22	EF78												26			320	18
23	EF78												31			312	22
24	EF78												21			305	26
25	EF78												19			299	26
26	EF78															293	22
27	EF78															285	28
28	EF78																
No. of Data Points			8	13	13	11	11	10	10	9	9		17	2	2	20	20
Mean			8.63	6.85	13.23	14.00	19.09	21.40	20.60	28.89	25.11		24.82	276.00	42.50	350.95	34.45
Standard Deviation			4.93	1.21	4.27	2.49	6.17	2.99	8.38	3.06	6.64		4.35	42.43	16.26	41.48	9.50
Range: From			-1	4	4	10	10	17	6	25	14		19	246	31	285	18
To			15	9	19	18	28	26	30	33	34		32	306	54	417	50
Coefficient of Variation (%)			57.1	17.7	32.3	17.8	32.3	14.0	40.7	10.6	26.4		17.5	15.4	38.3	11.8	27.6

Table D2 Mid-Panel Deflections - Slab Type B

Floor	Grid	Time Since Form Removal and Corresponding Measured Deflection															
		Forms Removed		Load From 1 Floor		Load From 2 Floors		Load From 3 Floors		Load From 4 Floors		Shores Removed		April/82		July/82	
		t_1 (days)	Δ_1 (mm)	t_2 (days)	Δ_2 (mm)	t_3 (days)	Δ_3 (mm)	t_4 (days)	Δ_4 (mm)	t_5 (days)	Δ_5 (mm)	t_6 (days)	Δ_6 (mm)	t_7 (days)	Δ_7 (mm)	t_8 (days)	Δ_8 (mm)
8	EF89		9	6	18	13	21	20	28	26	33		23			417	28
9	EF89		5	7	12	14	17	20	20	27	15		24			411	36
10	EF89		3	7	6	13	10	20	9	27	8		18	306	32	404	42
11	EF89		9	6	11	13	13	20	27	28	24		19			397	43
12	EF89		14	7	17	14	23	22	29	32	32		35			391	42
13	EF89		7	7	23	15	22	25	27	33	30		30			384	25
14	EF89		19	8	26	18	34	26	44	33	48		41	279	63	877	48
15	EF89		22	9	19	18	25	25	29	29	32		27			369	42
16	EF89			8	13	15	17	19	21	25	27		22			359	25
17	EF89		12	7	21	11	24	17	27				27			351	33
18	EF89			4	16	10	18						32	246	57	344	44
19	EF89			6	15								27			340	26
20	EF89			7	13								27			334	25
21	EF89															327	28
22	EF89												34			320	26
23	EF89												36	214	36	312	19
24	EF89												26			305	25
25	EF89												18			299	22
26	EF89												28				
27	EF89															285	25
28	EF89															278	17

Continued ...

Table D2 Mid-Panel Deflections - Slab Type B Continued

Floor	Grid	Forms Removed		Load From 1 Floor		Load From 2 Floors		Load From 3 Floors		Load From 4 Floors		Shores Removed		April/82		July/82	
		t_1 (days)	Δ_1 (mm)	t_2 (days)	Δ_2 (mm)	t_3 (days)	Δ_3 (mm)	t_4 (days)	Δ_4 (mm)	t_5 (days)	Δ_5 (mm)	t_6 (days)	Δ_6 (mm)	t_7 (days)	Δ_7 (mm)	t_8 (days)	Δ_8 (mm)
8	HJ56		18	6	14	13	18	20	20	26	21		24			417	33
9	HJ56		20	7	12	14	27	20	30	27	36		38			411	38
10	HJ56		6	7	14	13	17	20	18	27	21		24	306	32	404	32
11	HJ56		0	6	6	13	10	20	14	28	17		19			397	35
12	HJ56		12	7	17	14	20	22	23	32	32		25			391	52
13	HJ56		9	7	18	15	20	25	26	33	30		38			384	40
14	HJ56		6	8	20	18	19	26	19	33	29		27	279	48	377	29
15	HJ56		19	9	18	18	19	25	17	29	31		25			369	52
16	HJ56			8	11	15	18	19	23	25	26		25			359	54
17	HJ56			7	3	11	5	17	15				8			351	44
18	HJ56			4	18	10	19						27	246	53	344	33
19	HJ56			6	13								20			340	33
20	HJ56			7	10								21			334	33
21	HJ56																
22	HJ56															320	21
23	HJ56												21	214	18	312	20
24	HJ56												25			305	26
25	HJ56												19			299	29
26	HJ56															293	29
27	HJ56															285	23
28	HJ56															278	24
Number of Data Points			17	26	26	22	22	20	20	18	18		34	8	8	40	40
Mean			11.18	6.85	14.77	14.00	18.91	21.40	23.30	28.89	27.33		25.88	261.25	42.38	349.35	32.53
Standard Deviation			6.56	1.19	5.29	2.43	6.13	2.91	7.55	2.97	8.93		6.84	36.97	15.28	42.96	9.72
Range: From			0	4	3	10	5	17	9	25	8		8	214	18	278	17
To			22	9	26	18	34	26	44	33	48		41	306	63	417	54
Coefficient of Variation (%)			58.7	17.4	35.8	17.4	32.4	13.6	32.4	10.3	32.7		26.4	14.2	36.1	12.3	29.9

Table D3 Mid-Panel Deflections - Slab Type C

Floor	Grid	Forms Removed t_1 (days)	Forms Removed Δ_1 (mm)	Load From 1 Floor t_2 (days)	Load From 1 Floor Δ_2 (mm)	Load From 2 Floors t_3 (days)	Load From 2 Floors Δ_3 (mm)	Load From 3 Floors t_4 (days)	Load From 3 Floors Δ_4 (mm)	Load From 4 Floors t_5 (days)	Load From 4 Floors Δ_5 (mm)	Shores Removed t_6 (days)	Shores Removed Δ_6 (mm)	April/82 t_7 (days)	April/82 Δ_7 (mm)	July/82 t_8 (days)	July/82 Δ_8 (mm)
8	FG89		8	6	17	13	19	20	24	26	28		24			417	34
9	FG89		-6	7	-2	14	5	20	10	27	14		20			411	31
10	FG89		4	7	10	13	13	20	12	27	14		17	306	33	404	43
11	FG89		10	6	11	13	19	20	24	28	28		26			397	42
12	FG89			7	2	14	8	22	13	32	17		11			391	38
13	FG89		4	7	14	15	21	25	23	33	24		25			384	31
14	FG89		5	8	16	18	25	26	28	33	33		27	279	47	377	24
15	FG89		13	9	18	18	22	25	31	29	33		26			369	46
16	FG89		13	8	13	15	20	19	22	25	28		24			359	35
17	FG89			7	19	11	23	17	26				26			351	32
18	FG89			4	15	10	19						31	246	64	344	33
19	FG89			6	16								22			340	32
20	FG89			7	12								24			334	36
21	FG89															327	37
22	FG89															320	23
23	FG89													214	32	312	23
24	FG89															305	22
25	FG89															299	19
26	FG89																
27	FG89															285	32
28	FG89															278	22
Number of Data Points			8	13	13	11	11	10	10	9	9			4	4	20	20
Mean			6.38	6.85	12.38	14.00	17.64	21.40	21.30	28.89	24.33		23.31	261.25	44.00	350.00	31.75
Standard Deviation			6.21	1.21	6.16	2.49	6.31	2.99	7.17	3.06	7.57		5.02	39.93	14.99	42.70	7.62
Range: From			-6	4	2	10	5	17	10	25	14		11	214	32	278	19
To			13	9	19	18	25	26	31	33	33		31	306	64	417	46
Coefficient of Variation (%)			97.3	17.7	49.8	17.8	35.8	14.0	33.7	10.6	31.1		21.5	15.3	34.1	12.2	24.0

Table D4 Mid-Panel Deflections - Slab Type C

Floor	Grid	Forms Removed t_1 (days)	Forms Removed Δ_1 (mm)	Load From 1 Floor t_2 (days)	Load From 1 Floor Δ_2 (mm)	Load From 2 Floors t_3 (days)	Load From 2 Floors Δ_3 (mm)	Load From 3 Floors t_4 (days)	Load From 3 Floors Δ_4 (mm)	Load From 4 Floors t_5 (days)	Load From 4 Floors Δ_5 (mm)	Shores Removed t_6 (days)	Shores Removed Δ_6 (mm)	April/82 t_7 (days)	April/82 Δ_7 (mm)	July/82 t_8 (days)	July/82 Δ_8 (mm)
		Time Since Form Removal and Corresponding Measured Deflection															
8	HJ67		12	6	6	13	12	20	14	26	16		18			417	33
9	HJ67		19	7	10	14	27	20	30	27	33		35			411	25
10	HJ67			7	5	13	4	20	7	27	7		10	306	24	404	45
11	HJ67		0	6	4	13	14	20	17	28	20		14			397	42
12	HJ67		11	7	16	14	16	22	21	32	27		23			391	41
13	HJ67		11	7	27	15	21	25	21	33	19		27			384	38
14	HJ67		7	8	14	18	15	26	17	33	24		23	179	45	377	35
15	HJ67		30	9	21	18	23	25	9	29	30		24			369	59
16	HJ67			8	9	15	16	19	18	25	20		20			359	44
17	HJ67		11	7	14	11	17	17	27				29			351	47
18	HJ67															344	41
19	HJ67			6	13								20			340	45
20	HJ67			7	12								22			334	48
21	HJ67															327	45
22	HJ67															320	25
23	HJ67												21	214	24	312	25
24	HJ67												20			305	39
25	HJ67															299	30
26	HJ67												34			293	35
27	HJ67															285	32
28	HJ67															278	36
Number of Data Points			8	12	12	10	10	10	10	9	9		15	3	3	21	21
Mean			12.63	7.08	12.58	14.40	16.50	21.40	18.10	28.89	21.78		22.67	266.33	31.00	347.48	38.57
Standard Deviation			8.80	0.90	6.67	2.22	6.31	2.99	7.17	3.06	7.84		6.67	47.29	12.12	43.45	8.62
Range: From			0	6	4	11	4	17	7	25	7		10	214	24	278	25
To			30	9	27	18	27	26	30	33	33		35	306	45	417	59
Coefficient of Variation (%)			69.7	12.7	53.0	15.4	38.2	14.0	39.6	10.6	36.0		29.4	17.8	39.1	12.5	22.4

Table D5 Mid-Panel Deflections - Slab Type D

Floor	Grid	Time Since Form Removal and Corresponding Measured Deflection															
		Forms Removed		Load From 1 Floor		Load From 2 Floors		Load From 3 Floors		Load From 4 Floors		Shores Removed		April/82		July/82	
		t_1 (days)	Δ_1 (mm)	t_2 (days)	Δ_2 (mm)	t_3 (days)	Δ_3 (mm)	t_4 (days)	Δ_4 (mm)	t_5 (days)	Δ_5 (mm)	t_6 (days)	Δ_6 (mm)	t_7 (days)	Δ_7 (mm)	t_8 (days)	Δ_8 (mm)
8	GH89		8	6	17	13	18	20	19	26	24		18			417	23
9	GH89		6	7	15	14	16	20	18	27	23		29			411	34
10	GH89		4	7	9	13	13	20	12	27	15		15	306	34	404	28
11	GH89		0	6	2	13	8	20	14	28	17		16			397	23
12	GH89		10	7	15	14	19	22	12	32	22		25			391	48
13	GH89		4	7	15	15	18	25	21	33	23		22			384	50
14	GH89		5	8	11	18	22	26	25	33	31		27	279	51	377	31
15	GH89		4	9	18	18	23	25	31	29	35		28			369	53
16	GH89			8	16	15	23	19	25				28			359	36
17	GH89		10	7	16	11	20	17	25				26			351	31
18	GH89			4	13	10	10							246	62	344	33
19	GH89			6	13								24			340	42
20	GH89															334	41
21	GH89															327	40
22	GH89												28			320	18
23	GH89												27	214	33	312	21
24	GH89												24			305	17
25	GH89												20			299	21
26	GH89												35			293	31
27	GH89															285	42
28	GH89															278	39
Number of Data Points			9	12	12	11	11	10	10	8	8		16	4	4	21	21
Mean			5.67	6.83	13.33	14.00	17.27	21.40	20.20	29.38	23.75		24.50	261.25	45.00	347.48	33.43
Standard Deviation			3.24	1.27	4.38	2.49	5.08	2.99	6.37	2.88	6.61		5.25	39.93	14.02	43.45	10.58
Range: From			0	4	2	10	8	17	12	26	15		15	214	33	278	17
To			10	9	18	18	23	26	25	33	35		35	306	62	417	53
Coefficient of Variation (%)			57.1	18.6	32.9	17.8	29.4	14.0	31.5	9.8	27.8		21.4	15.3	31.2	12.5	31.7

Table D6 Mid-Panel Deflections - Slab Type E

Floor	Grid	Forms Removed t_1 (days)	Forms Removed Δ_1 (mm)	Load From 1 Floor t_2 (days)	Load From 1 Floor Δ_2 (mm)	Load From 2 Floors t_3 (days)	Load From 2 Floors Δ_3 (mm)	Load From 3 Floors t_4 (days)	Load From 3 Floors Δ_4 (mm)	Load From 4 Floors t_5 (days)	Load From 4 Floors Δ_5 (mm)	Shores Removed t_6 (days)	Shores Removed Δ_6 (mm)	April/82 t_7 (days)	April/82 Δ_7 (mm)	July/82 t_8 (days)	July/82 Δ_8 (mm)
		Time Since Form Removal and Corresponding Measured Deflection															
8	HJ78		16	6	5	13	1	20	12	26	14		19			417	31
9	HJ78					14	4	20	7	27	14		9			411	36
10	HJ78		4	7	14	13	15	20	16	27	19		20	306	36	404	40
11	HJ78		8	6	12	13	19	20	23	28	24		24			397	38
12	HJ78		10	7	15	14	16	22	18	32	27		23			391	40
13	HJ78		30	7	30	15	31	25	31	33	40		47			384	51
14	HJ78		5	8	12	18	13	26	16	33	23		25	279	52	377	40
15	HJ78		19	9	25	18	38	25	20	29	34		31			369	75
16	HJ78			8	8	15	14	19	15	25	17		17			359	34
17	HJ78		5	7	10	11	11	17	23				20			351	40
18	HJ78			4	15	10	17						25	246	61	344	45
19	HJ78															340	41
20	HJ78			-7	11								24			334	40
21	HJ78															327	37
22	HJ78															320	35
23	HJ78												22	214	29	312	28
24	HJ78												24			305	23
25	HJ78												24			299	33
26	HJ78												32				
27	HJ78															285	39
28	HJ78															278	35
Number of Data Points			8	11	11	11	11	10	10	9	9		16	4	4	20	20
Mean			12.13	6.91	14.27	14.00	16.27	21.40	18.10	28.89	23.56		24.13	261.25	44.50	350.20	39.05
Standard Deviation			9.03	1.30	7.27	2.49	10.61	2.99	6.64	3.06	8.93		8.08	39.93	14.62	42.70	10.34
Range: From			4	4	5	10	1	17	7	25	14		9	214	29	278	23
To			30	9	30	18	38	26	23	33	40		47	306	61	417	75
Coefficient of Variation (%)			74.4	18.8	51.0	17.8	65.2	14.0	36.7	10.6	37.9		33.5	15.3	32.9	12.5	26.5

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