Tests to Determine the Lateral Distribution of Vertical Loads in a Long-Span Hollow-Core Floor Assembly

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Tests to determine the lateral width of distribution of vertical loads on an untopped slab to adjacent slabs have previously[1-3] been made, although primarily on narrow slabs of moderate span.

These tests showed that vertical load is transferred to adjacent slabs through the continuous longitudinal grouted shear keys. As a result of these previous tests, an effective width of about 40 percent of the span length has been used by some designers.[4]

The purpose of this test program was to experimentally determine the distribution of resisting internal moments within 8-ft (2.44 m) wide, long-span, untopped hollow-core slabs. A full-scale five-slab assembly, as shown in Fig. 1, was subjected to a total of nine different vertical loading conditions.

The tests are limited in that only one span length of 44.25 ft (13.5 m) and one slab thickness of 12 in. (305 mm) were used. Also, the test results do not apply to shorter spans and to conditions where the vertical loads are positioned close to the supports. In addition, no attempt was made to determine shear distribution at the supports or along the longitudinal shear key joints.

The fabrication of the hollow-core slab units and the testing of the floor slab assembly were conducted at a precasting plant in Hamden, Connecticut, belonging to Blakeslee Prestress, Inc.

TEST DETAILS

Hollow-Core Specimens

Five slabs were used in the 37.5-ft (11.4 m) wide x 44.25-ft (13.5 m) clear span test assembly shown in plan in Fig. 2. Through-slab holes were made by removing vertical web members and the top and bottom flanges at midspan in two slabs (Nos. 1 and 5). Holes were also produced through the top and bottom flanges between the web members in two slabs (Nos. 2 and 4). Slab No. 3 contained no holes. These 1 x 1-ft or 1 x 2-ft (305 x 305 mm or 305 x 610 mm) holes, which can be seen in Fig. 3, are for mechanical equipment requirements.

The specimens were cast with normal-weight concrete having a unit weight of 147.5 pcf (2360 kg/m³). Compressive strength (f'_c) and modulus of elasticity (E_c) tests using ASTM procedures were made on 6 x 12-in. (152 x

Synopsis

A series of nine tests was performed on a full-scale, long-span hollow-core floor slab assembly to determine the distribution of resisting internal moments within the 8-ft (2.4 m) wide untopped slabs. The test assembly was 37.5 ft (11.4 m) wide and had a clear span of 44.25 ft (13.5 m).

Load-induced curvature in each slab was determined from measured strains and midspan deflection characteristics were measured. The test results showed good lateral load distribution characteristics. For the given test conditions, the width of significant distribution of loads ranged from 36 to 54 percent of the span length.

Fig. 1. Load distribution test on full-scale floor slab assembly.

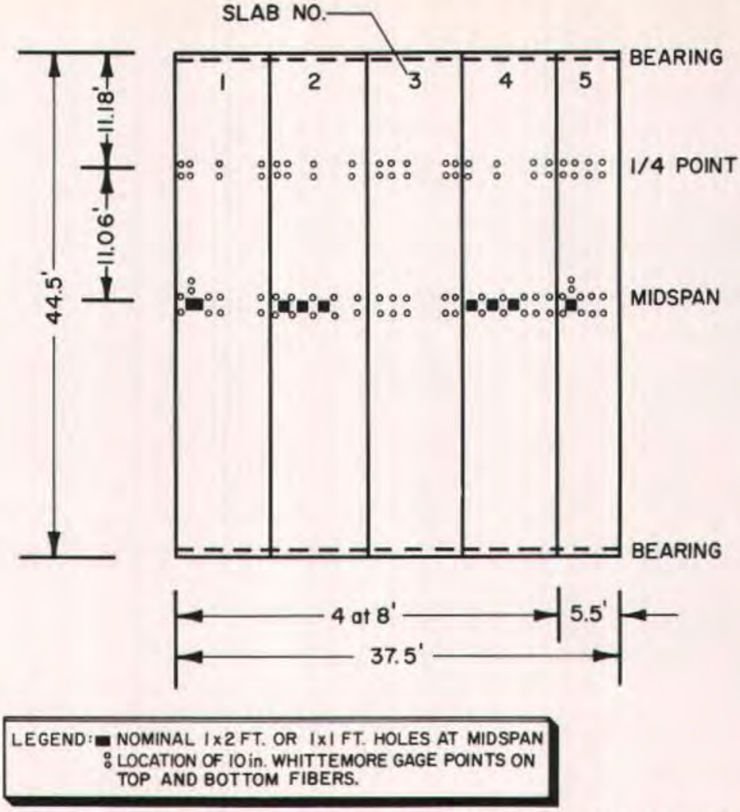


Fig. 2. Plan view of test assembly and strain gage locations. (Note: 1 ft = 0.305 m.)

305 mm) heat-cured cylinders at ages of 9 and 11 hours at release of prestress and at 28 days. These data are presented in Table 1. The average 28-day strength and modulus values were 5400 psi (37.2 MPa) and 4.73 x 10^6 psi (32,600 MPa), respectively. Measured E_c values are also compared in Table 1 with values calculated using Section 8.5.1 of ACI 318-77.

The slab cross section was measured at both saw-cut ends so that actual cross-sectional properties could be calculated. These properties at sections with and without the holes are given in Table 2.

The nominal slab cross section and the nonfinal and measured cross-sectional properties are shown in Fig. 4.

All five slabs were weighed, and the average weight was 70 psf (341 kg/m^2). The calculated weight, based upon measured dimensions, is 67 psf (327 kg/m^2). The remainder is considered to be bonded aggregate in the voids.

Test Assembly and Procedures

The slabs were supported at each end on high-density plastic bearing pads. A 5-ft (1.5 m) space was provided beneath the assembly to allow strain measurements and crack examination on the bottom surface. The slab assembly itself was supported on prestressed I-girders.

The slabs were erected at an age of 35 days without grouting the shear keys. An individual load test, as shown

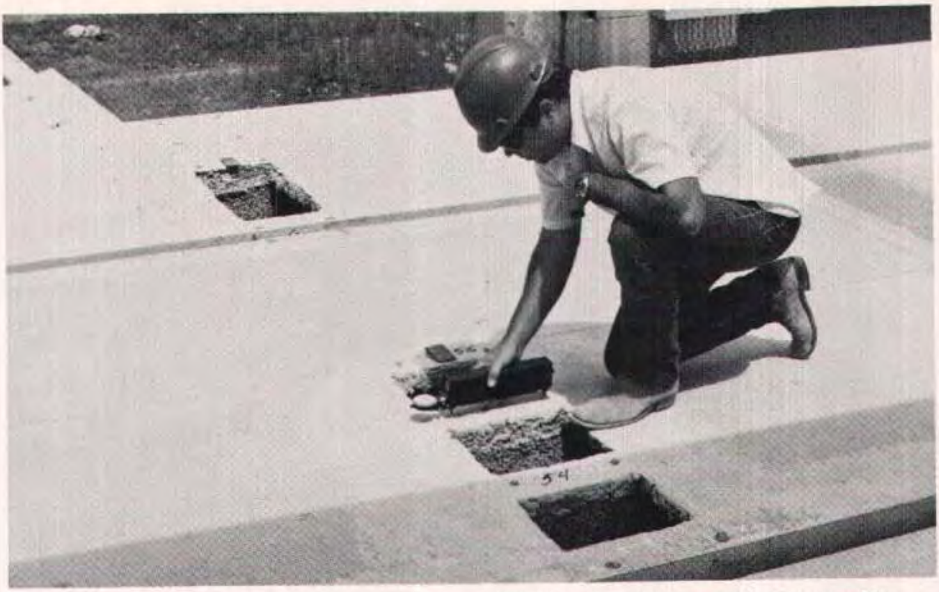
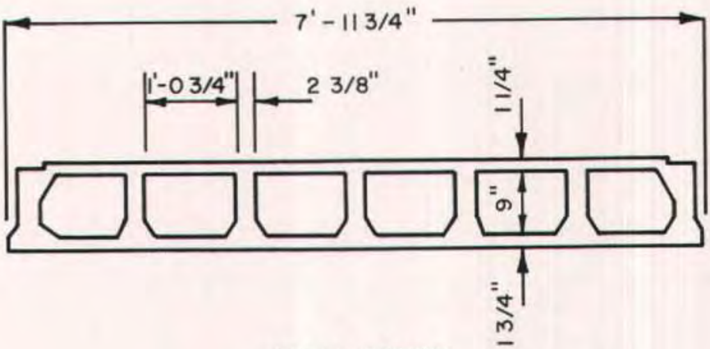


Fig. 3. Holes at midspan in Slabs 4 and 5 and Whittemore strain gage being used to measure top fiber strain.



Cross Section Properties.

Nominal	Measured
A_c = 431 sq in.	A_c = 520 sq in.
I_g = 8512 in.^{4}	I_g = 10,308 in.^{4}
Y_b = 6.07 in.	Y_b = 6.09 in.
W_{dl} = 56.1 psf	W_{dl} = 67.0 psf
t = 12.0 in.	t = 12.17 in.

Note: 1 in. = 25.4 mm; 1 psf = 4.9 kg/m^2.

Fig. 4. Cross section with nominal and measured section properties.

Table 1. Compressive strength and modulus of elasticity data from 6 x 12-in. cylinders.

(a) At detensioning

Concrete age	Measured compressive strength, f'_c (psi)	Measured E_c* (10^6 psi)	Calculated E_c† (10^6 psi)	Measured E_c / Calculated E_c
9 hr	3780	3.69	3.64	1.01
9 hr	3710	3.69	3.60	1.03
9 hr	3470	3.29	3.48	0.94
9 hr	3540	3.16	3.52	0.90
9 hr	3340	3.03	3.42	0.88
9 hr	3360	3.54	3.43	1.03
11 hr	3450	3.15	3.54	0.89
11 hr	3630	3.40	3.62	0.94
		Avg. = 3.37		Avg. = 0.95

(b) At 28 days

Concrete age	Measured compressive strength, f'_c (psi)	Measured E_c* (10^6 psi)	Calculated E_c† (10^6 psi)	Measured E_c / Calculated E_c
28 days	5730	4.72	4.49	1.05
28 days	5620	4.85	4.32	1.12
28 days	5160	4.92	4.14	1.19
28 days	5060	4.42	4.10	1.08
		Avg. = 4.73		Avg. = 1.11

Note: 1 in. = 25.4 mm; 1 psi = 0.006895 MPa.
*For stress variation from 200 to 1200 psi.
†ACI 318-77 equation.

in Fig. 5, was made on each slab to establish the relationship between moment, midspan deflection, and curvature from measured strains. After these tests, the slabs were positioned next to each other and grout was cast into the shear keys. The grout was allowed to cure for 12 days, prior to subsequent testing. As a result, the slabs were about 50 days old during the load distribution tests.

A 7-in. (178 mm) slump portland cement and sand grout were used in the longitudinal shear keys. A preliminary study was conducted to select a grout mixture which would produce a 28-day compressive strength of about 3500 psi (24.1 MPa). However, the measured compressive strength and modulus of elasticity of the grout were about 2300 psi (15.9 MPa) and 2.80 x 10^6 psi (19,300 MPa), respectively, when the load distribution tests were undertaken.

A section through a longitudinal shear key is shown in Fig. 6. The maximum keyway width is 2 to 3 in. (510 to 760 mm) and the depth is 10¾ in. (273 mm). The continuous keyway is periodically interrupted on both sides with ½-in. wide x 6-in. long (12.7 x 163 mm) indentations cast into the sides of the slabs. The longitudinal center-to-center spacing of this projection is 12 in. (305 mm).

A cross section of the three ways the hardened grout can appear, depending upon the position of adjacent slabs, is shown in Fig. 7.

Table 2. Calculated hollow-core slab section properties.

Section properties	Sections with holes and webs removed*				
	Slab 1	Slab 2	Slab 3	Slab 4	Slab 5
Slab width, in.	70	66	96	66	41
Number of webs	6	7	7	7	4
A_c, sq in.	372	419	520	419	271
I_c, in.^{4}	7432	7511	10308	7511	4621
Y_b, in.	6.05	6.01	6.09	6.01	5.93
e, in.	3.21	3.17	3.25	3.17	3.10
P_i, kips	463	463	463	463	318
No. of ½-in. strand	16	16	16	16	11

Section properties	Sections without openings*	
	Slabs 1 to 4	Slab 5
Slab width, in.	96	67
Number of webs	7	5
A_c, sq in.	520	391
I_c, in.^{4}	10308	7228
Y_b, in.	6.09	6.08
e, in.	3.25	3.18
P_i, kips	463	405
No. of ½-in. strand	16	14

Note: 1 in. = 25.4 mm; 1 kip = 453.6 kg.
*From cut cross sections at both ends of slab.

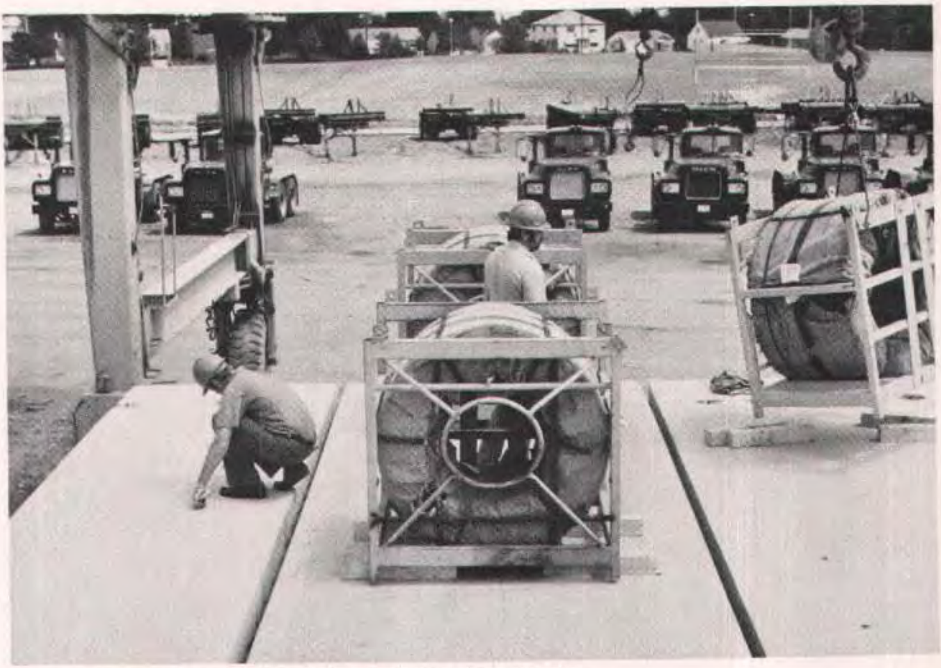


Fig. 5. Portion of assembly during individual load tests.

Table 3. Calculated bottom fiber stresses in slabs during individual load tests.

Slab No.	Midspan moment* (in.-kips)	Bottom fiber stress† (psi)	
		Midspan	One-quarter point
1	3130	+462 (T)	−50 (C)
2	3027	+485 (T)	−71 (C)
3	3336	+458 (T)	+9 (T)
4	3027	+485 (T)	−71 (C)
5	1891	+355 (T)	−452 (C)

Note: 1 in.-kip = 0.113 kN-m; 1 psi = 0.006895 MPa.
*From total dead and applied loads.
†Using measured section properties and a prestress loss of 15 percent. Note that "*T*" denotes tension and "*C*" is compression.

Loading

Coils of prestressing strand were used for the test loads. The average weight of each coil, steel coil rack and wooden support timbers was 6875 lbs (3119 kg). As shown in Fig. 5, each coil was supported on four 4 x 4-in. (102 x 102 mm) wood timbers positioned across two vertical webs.

Fig. 6. Cross section of shear key with no castellations showing.

When the ungrouted slabs were loaded as separate units, the combination of dead and applied load produced the moments given in Fig. 8. As shown in Table 3, the calculated bottom fiber tensile stress at midspan was about 6.4 $\sqrt{f'_c}$. Slab 5 was loaded to a calculated bottom fiber tensile stress at midspan of about 4.8 $\sqrt{f'_c}$. These stress levels were presumed to not cause cracking.

After the five individual load tests were completed, the keyways were grouted and the load distribution tests followed when the same loads and loading patterns previously applied on Slabs 1, 3 or 4 were re-applied separately to Slabs 1, 3, and 4. A supplementary load distribution test was then made on Slab 3 where the applied loads were increased. The load and loading arrangements for this supplementary test are shown in Fig. 9.

During the supplementary load test, the maximum total midspan moment on Slab 3 was 7172 in.-kips (810 kN•m). This total moment is 33 percent greater than the calculated ultimate bending strength of 5411 in.-kips (611 kN•m) for Slab 3, based upon strain compatability.

Each load test required about 2 to 3 hours to complete. The loads on Slab 3

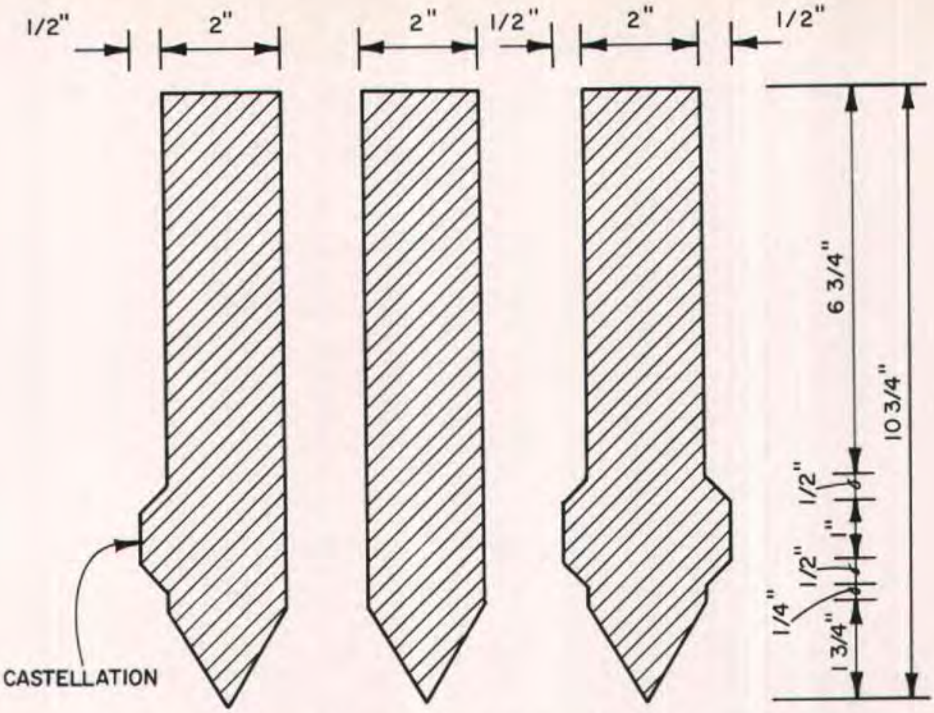
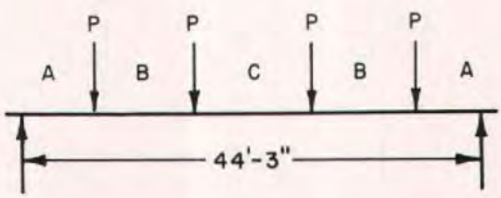


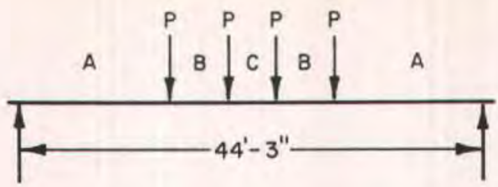
Fig. 7. Three possible shapes of cross section of castellated longitudinal shear key between adjacent slabs, depending upon position of adjacent slab. (1 in. = 25.4 mm.)



Slab No.	Load point dimensions (in.)			Moments from applied loads* (in.-kips)		Moments from dead loads (in.-kips)	
	A	B	C	One-quarter-point	Midspan	One-quarter-point	Midspan
1	48.0	120.0	195.0	1243	1485	1234	1645
2	42.6	115.8	214.2	1206	1382	1234	1645
3	62.4	121.2	163.8	1342	1691	1234	1645
4	42.6	115.8	214.2	1206	1382	1234	1645
5	108.0	0	315.0	743	743	861	1148

*P = 6.875 kips. Note: 1 in. = 25.4 mm; 1 in.-kip = 0.113 kN·m; 1 kip = 453.6 kg.

Fig. 8. Load locations and moments for individual tests.



Slab No.	Load point dimensions (in.)			Moments from applied loads, (in.-kips)	
	A	B	C	One-quarter-point	Midspan
3	171.5	59.0	70.0	3650*	5527*

Note: 1 in. = 25.4 mm; 1 in.-kip = 0.113 kN•m; 1 kip = 453.6 kg.

Fig. 9. Load locations for supplementary load distribution test on Slab 3.

were maintained for 24 hours during the final supplementary load test. Recovery of immediate deflection was measured when the loads were removed.

Instrumentation

Whittemore strain gage plugs were installed on the top and bottom concrete surfaces directly over a vertical web at 94 locations. Location of the gages is shown in Fig. 2. A 10-in. (254 mm) gage length was used to obtain strain to an accuracy of $\pm 15 \times 10^{-6}$ in./in. Each slab section was instrumented with four or five strain gage locations (both top and bottom).

The average top and average bottom strain data obtained from each slab section was used to calculate curvature at the one-quarter point and midspan of each slab. Effects of temperature from the out-of-doors exposure were compensated for by adjusting the calculated curvatures from strain readings measured adjacent to the support.

The average curvature, ϕ, within each slab width was calculated for each test as follows:

$$\phi = \frac{1}{nt} \sum_{i=1}^{n} \left[\epsilon_{t_i} - \epsilon_{b_i} \right]$$

where

ϕ = calculated curvature from strain, $10^{-6} \times \text{in.}^{-1}$

ϵ_t = top surface strain, 10^{-6} in./in.

ϵ_b = bottom surface strain, 10^{-6} in./in.

n = number of strain locations per slab width

t = slab thickness, in.

Midspan deflection was measured to an accuracy of 1/64 in. (0.41 mm) using a constant-tension wire reference and a steel machinist ruler.

DISCUSSION OF TEST RESULTS

Individual Load Tests

During the five individual load tests, a single hairline crack was observed on the bottom surface of Slabs 1, 2, and 4 at the hole locations at midspan, even though the calculated midspan tensile stress was 84 to 88 percent of the commonly accepted modulus of rupture of $7.5\sqrt{f'_c}$. The crack in each slab extended

Table 4. Calculated curvature at one-quarter point and measured midspan deflection from individual tests.

Loaded slab	Midspan moment from applied loads (in.-kips)	Curvature at one-quarter point, ϕ* (10^{-6} x in.$^{-1}$)	Midspan deflection (in.)
1	1485	27.0	1.09
2	1382	27.0	1.06
3	1691	31.3	1.14
4	1382	26.0	1.14
5	743	23.6	0.78

Note: $\frac{1}{10^6 \text{ in.}} = \frac{0.393}{10^7 \text{ mm}}$; 1 in.-kip = 0.113 kN-m;
1 in. = 25.4 mm.
*From measured strain data.

Table 5. Comparison of theoretical and calculated curvature at one-quarter point during individual load tests.

Loaded slab	Curvature, ϕ, at one-quarter point, 10^{-6} x in.$^{-1}$		$\frac{\phi \text{ theoretical}}{\phi \text{ calculated from strain}}$
	Theoretical calculation*	Calculated from strain data	
1	25.5	27.0	0.94
2	24.7	27.0	0.91
3	27.5	31.3	0.88
4	24.7	26.0	0.95
5	21.7	23.6	0.92
			Avg: 0.92

Note: $\frac{1}{10^6 \text{ in.}} = \frac{0.393}{10^7 \text{ mm}}$; 1 psi = 0.006895 MPa; 1 in. = 25.4 mm.
*Calculated using $M/EI = \phi$ and assuming $E = 4.73 \times 10^6$ psi and $I = 10308$ or 7228 in.^{4}

up only about 1 to 2 in. (25.4 to 50.8 mm) and not across the full width. However, since the cracks were within the Whittemore gage lengths, this required that only the one-quarter point calculated curvatures be utilized since the distribution calculations required uncracked concrete. As shown in Fig. 8, the one-quarter-point moment from applied loads, which is used for all curvature calculations, ranged from 79 to 100 percent and averaged 87 percent of the midspan moment from applied loads.

The calculated curvatures and measured midspan deflections are given in Table 4. In Table 5, the calculated theoretical one-quarter-point curvature is given for each test using measured values of $E_c = 4.73 \times 10^6$ psi (32613 MPa) and $I = 10{,}308$ or 7228 in.^{4} (4.3×10^9 or 3.0×10^9 mm^4). The curvatures calculated from measured strain average about 8 percent higher than theoretical curvatures. Accordingly, the average EI value assumed in Table 5 is about 8 percent higher than indicated by the behavior, a reasonable differ-

Table 6. Comparison of measured and calculated deflections at midspan during individual load tests.

Specimen loaded	Deflection, Δ, at midspan, in.		$\frac{\Delta \text{ measured}}{\Delta \text{ calculated}}$
	Measured	Calculated*	
1	1.09	1.07	1.02
2	1.06	1.00	1.06
3	1.14	1.16	0.98
4	1.14	1.00	1.14
5	0.78	0.80	0.98
			Avg: 1.04

Note: 1 in. = 25.4 mm; 1 lb = 0.4536 kg; 1 psi = 0.006895 MPa.
*Assuming EI = 0.92 x (4.73 x 10^6 psi) x (10308 or 7228 in.^{4}). P = 6875 lbs and effect of all holes has been included.

Table 7. Comparison of moments from applied loads with calculated internal resisting moments at one-quarter point of test assembly during distribution tests.

Slab loaded	Slab number	Calculated one-quarter-point curvature from strains, ϕ (10^{-6} x in.$^{-1}$)	Calculated one-quarter-point internal resisting moment* (in.-kips)	Percent of total one-quarter-point calculated internal resisting moment in each slab
1	1	13.6	610	49.4
	2	8.9	399	32.3
	3	2.5	112	9.1
	4	2.0	90	7.3
	5	0.8	25	1.9
			1236	
3	1	4.11	185	14.9
	2	6.57	295	23.8
	3	7.40	332	26.8
	4	7.07	317	25.5
	5	3.53	111	9.0
			1240	
4	1	2.55	114	8.4
	2	3.37	151	11.2
	3	5.92	266	19.7
	4	11.59	520	38.5
	5	9.53	300	22.2
			1351	
3 (Supplementary test)	1	8.9	399	11.6
	2	17.6	789	22.9
	3	20.7	929	26.9
	4	20.7	929	26.9
	5	12.8	403	11.7
			3499	

*Calculated using $M = \phi EI$ while assuming EI = (0.92 x 4.73 x 10^6 psi) x 10308 or 7228 in.^{4}

Table 8. Load distribution based on midspan deflection.

Slab loaded	Slab number	Midspan moment from applied loads (in.-kips)	Measured midspan deflection, Δ (in.)	Load distribution in each slab based upon midspan deflection* (percent)
1	1	1485	0.39	38.3
	2	—	0.28	27.5
	3	—	0.13	12.8
	4	—	0.14	13.8
	5	—	0.11	7.6
3	1	—	0.31	19.1
	2	—	0.39	24.1
	3	1691	0.36	22.2
	4	—	0.36	22.2
	5	—	0.28	12.1
4	1	—	0.09	11.3
	2	—	0.09	11.3
	3	—	0.20	25.3
	4	1382	0.25	31.7
	5	—	0.23	20.4
3 (Supplementary test)	1	—	0.70	17.0
	2	—	0.89	21.6
	3	5527	1.14	27.7
	4	—	0.88	21.4
	5	—	0.72	12.3

Note: 1 in. = 25.4 mm; 1 in.-kip = 0.113 kN-m; 1 psi = 0.006895 MPa.

*Calculated percent load carried by jth slab $= \dfrac{\Delta j \times (EI)j}{\sum_{i=1}^{5} [\Delta_i \times (EI)_i]} \times 100$

with $EI = (0.92 \times 4.73 \times 10^6 \text{ psi}) \times 10308$ or 7228 in.^{4}

ence considering the normal variability of E and I.

The measured deflection data are compared in Table 6 with calculated deflections. In this case, the EI value assumed in the calculations is 8 percent less than that obtained by tests on cylinders and field measurements of the cross sections. The comparison of measured to calculated deflection using this assumption is quite good, with an average difference of only 4 percent.

Initial Load Distribution Tests

Load on Specimen 1—The one-quarter-point moment from applied loads for the Slab 1 test was 1243 in.-kips (140 kN•m). This same loading scheme was applied to Slab 1 after the grouting was completed. Strains and deflection of all five slabs within the grouted assembly were measured. As soon as the load was applied to Slab 1, a longitudinal hairline crack developed between Slab 1 and the grouted keyway between Slabs 1 and 2.

The calculated curvatures of all five slabs during this test are given in Table 7. The measured midspan deflections are given in Table 8. The calculated internal resisting moment at the one-quarter point within each slab is also given in Table 7.

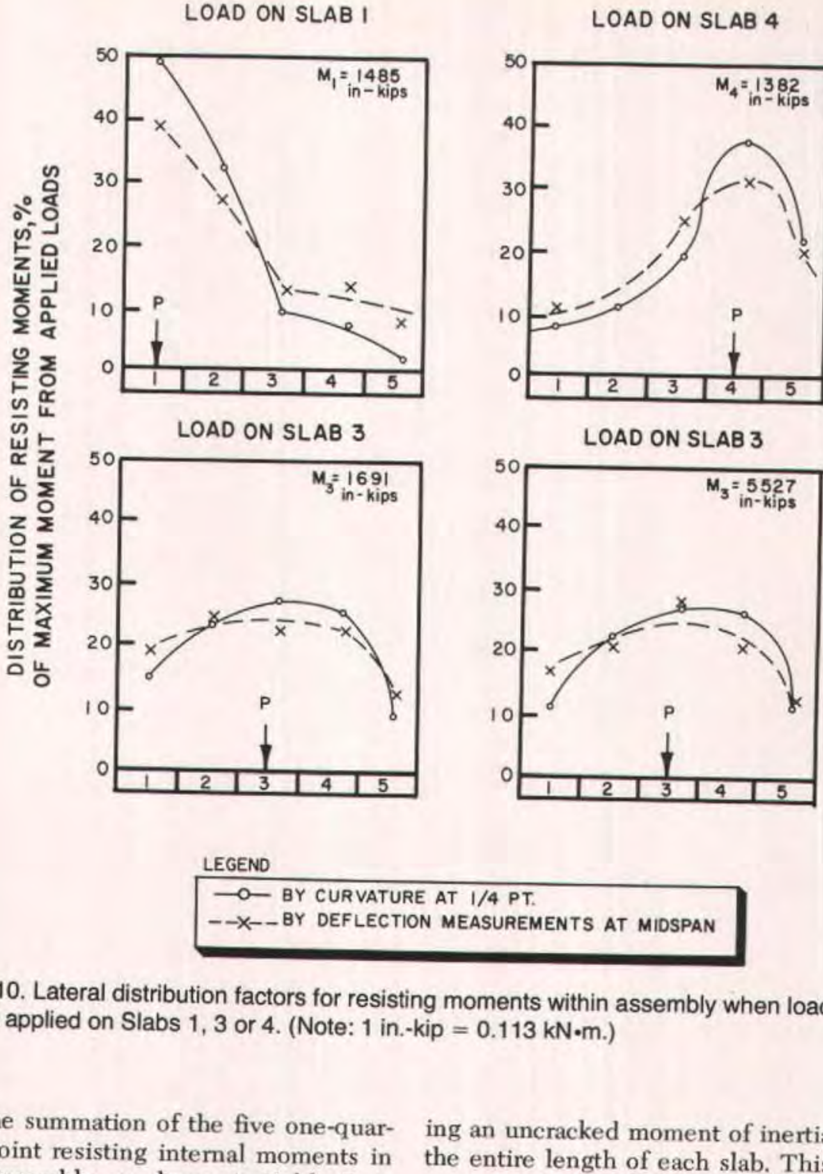


Fig. 10. Lateral distribution factors for resisting moments within assembly when loads were applied on Slabs 1, 3 or 4. (Note: 1 in.-kip = 0.113 kN•m.)

The summation of the five one-quarter-point resisting internal moments in the assembly, as shown in Table 7, is equal to 1236 in.-kips (139.7 kN•m) or 99.4 percent of the one-quarter-point moment from applied loads of 1243 in.-kips (140.4 kN•m). The percent distribution of these internal moments in the five-slab assembly is also given in Table 7.

The percent distribution of the vertical load in each slab was also calculated using elastic deflection theory assuming an uncracked moment of inertia for the entire length of each slab. This assumption is reasonable since only three hairline cracks occurred previously and these cracks did not re-open during this test. These distribution values are given in Table 8.

A comparison of the distribution of the internal resisting moments and loads using curvature or deflection data, respectively, is shown in Fig. 10. The results are very similar.

Load on Specimen 3—The results of

the load distribution test are given in Tables 7 and 8. The summation of the five internal resisting one-quarter-point moments in the assembly using the curvature method is equal to 1240 in.-kips (140.1 kN•m), or 92 percent of the 1342 in.-kips (151.6 kN•m) one-quarter-point moment from applied loads.

The comparison of the distribution of internal moments and loads using curvature or deflection data, respectively, is shown in Fig. 10. Both methods give nearly equal distribution factors.

Load on Specimen 4—The results of the load distribution test are given in Tables 7 and 8. The summation of the five internal resisting one-quarter-point moments in the assembly using the curvature method is equal to 1351 in.-kips (152.7 kN•m), or 112 percent of the 1206 in.-kips (136.3 kN•m) one-quarter-point moment from applied loads.

The comparison of the distribution factors is shown in Fig. 10. Again, it can be seen that both methods give nearly equal distribution factors.

Supplementary Test on Specimen 3

Slab 3 was loaded in a supplementary test to a higher level than in the individual load test and the initial load distribution test. Loads producing a midspan moment of 5527 in.-kips (624.6 kN•m) were applied. This moment is 227 percent higher than the 1691 in.-kips (191.1 kN•m) midspan moment applied in the earlier tests.

The deflection data are given in Table 8. The deflection of Slab 3 was 1.14 in. (29 mm) during the supplementary test. This is the same deflection as when this same slab (ungrouted) was loaded individually to 1691 in.-kips (191.1 kN•m).

The results of the distribution of internal resisting moments at this load level are given in Tables 7 and 8. The summation of the five internal resisting one-quarter-point moments in the assembly using the curvature analysis is equal to 3449 in.-kips (389.7 kN•m) which is equal to 94 percent of the 3650 in.-kip (412.4 kN•m) one-quarter-point moment from applied loads.

The comparison of the distribution of moments or loads using curvature or deflection data, respectively, is shown in Fig. 10. It can be seen that both methods give nearly equal distribution factors.

Distribution factors for Slab 3 loaded to midspan moment levels of 1691 and 5527 in.-kips (191.1 and 624.6 kN•m) are compared in Fig. 10. These distribution factors are essentially the same for these two significantly different load levels. The curvature analysis for the 5527 in.-kips (624.6 kN•m) moment level assigns 26.9 percent of the moment to Slab 3. This results in an internal moment of 1487 in.-kips (168.0 kN•m) in Slab 3 which is equal to 88 percent of the 1691 in.-kips (191.1 kN•m) moment during the individual test on Slab 3 where an identical midspan deflection of 1.14 in. (29 mm) was measured.

A plot of maximum moment from applied loads versus measured midspan deflection is given in Fig. 11, showing a linear relationship for the various load distribution tests performed on Slab 3. This observation, in combination with the other measured data, indicates that Slab 3 was able to carry a high load while still having a stress level in the

Table 9. Immediate recovery of deflection for various slabs.

Slab No.	Immediate recovery percent of initial deflection
1	94.2
2	96.6
3	86.0
4	97.7
5	93.1
Avg.	93.5

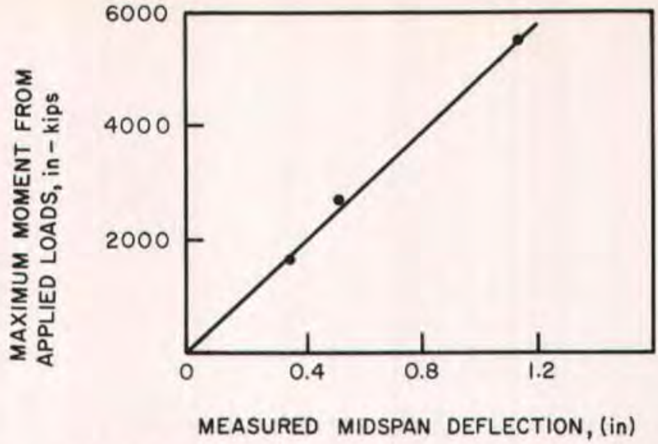


Fig. 11. Moment vs. deflection data of Slab 3. (1 in. = 25.4 mm; 1 in.-kip = 0.113 kN•m.)

concrete which was essentially equal to that caused by ungrouted individual loading when the calculated concrete tensile stress reached about 6.4 $\sqrt{f'_c}$.

The applied loads producing the 5527 in.-kips (624.6 kN•m) moment level were left on the test assembly for 24 hours. The loads were then removed and the immediate recovery of midspan deflection was measured. The recovery for the five slabs is summarized in Table 9. The average recovery was 93.5 percent.

Distribution Width

In determining the distribution width, it is assumed that load distribution to adjacent slabs was significant if the curvatures at the one-quarter-point or midspan deflection indicated load distributions of 20 percent or more into a given slab. The effective distribution width as a function of span length for the three loading conditions employed in these tests is summarized in Table 10.

The measured data show that two to three slabs exhibited significant load participation and that the effective width for this long span test assembly varied from 36 to 54 percent of the span length, even at high loads during the supplementary test on Slab 3.

SUMMARY AND CONCLUSIONS

A series of full-scale lateral load distribution tests on a long-span untopped hollow-core slab assembly was conducted to measure the distribution of internal resisting moments within a 37.5-ft (11.4 m) wide, five-slab assembly as each individual slab was loaded. The only vertical load-transfer mechanism between the 44.25-ft (13.5 m) clear span slabs was an unreinforced grouted shear key. The compressive strength of the concrete in the prestressed slabs and the grout in the shear key was 5400 and 2300 psi (37.2 and 15.9 MPa), respectively, during the testing period.

Prior to the load distribution tests, each slab was individually loaded to determine by measurement the actual uncracked *EI* stiffness value. These tests showed that the curvatures determined from measured bending strains compared closely with theoretical curvatures.

The loads applied to each individual

Table 10. Effective width distribution for three different loading positions.

Load position	Number of slabs with significant participation	Effective width, percent of span length
On exterior Slab 1	2	36
On interior Slab 4 next to exterior Slab 1	3	54
On interior Slab 3, two slabs away from exterior Slabs 1 and 5	3	54

slab in the grouted assembly during the load distribution tests was equal to the loads that would produce a midspan bottom fiber tensile stress of 6.4 $\sqrt{f'_c}$ if the slab was loaded as a separate unit. When this level of load was applied, a longitudinal hairline crack was observed in the longitudinal shear key between the loaded and non-loaded slabs.

The load distribution tests showed that the curvatures obtained from measured strain were quite accurate for determining load distribution since the sum of the one-quarter-point internal resisting moments calculated from curvatures ranged from 92.0 to 112.0 percent, with an average of 98.9 percent of the one-quarter-point moment from applied loads.

The test results showed good lateral load distribution characteristics. If at least 20 percent load participation is regarded as significant, these tests show that two to three slabs participated significantly and the width of significant distribution ranged from 36 to 54 percent of the span length.

It is recommended that further tests be made on similar test assemblies having different geometries, in order to develop a rational load distribution design procedure for this type of construction.

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