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Composite design for buildings summary of test results, June 1960

C. Culver

P. J. Zarzeczny

G. C. Driscoll Jr.

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COMPOSITE DESIGN FOR BUILDINGS

SUMMARY OF TEST RESULTS

Beams B-7, B-8, B-9

(For Committee Use only)

Since the completion of Progress Report No. 1, "TESTS OF COMPOSITE BEAMS FOR BUILDINGS", three additional beam tests and three additional pushout tests were conducted. These are the tests agreed upon by the Committee in the meeting of February 1, 1960 as stated in the minutes of that meeting.

The attached Tables 1 through 8 give a preliminary summary of the results of these tests. Results of these tests will be incorporated in afinal report when evaluation of all data has been completed.

C. Culver
P. J. Zarzeczny
G. C. Driscoll

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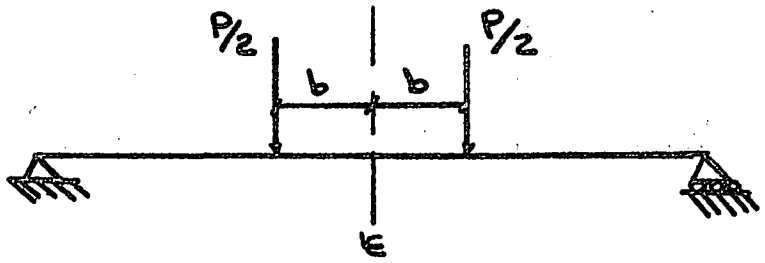
TABLE 1

Designation of Beam Specimens



Specimen	Connector Type	Connector Spacing c (in.)	Test No.	Load Spacing 2b (in.)	Test Designation
B7	1/2" dia.L studs	2at7.5	1	18	B7-S1
			2	36	B7-S2
B8	1/2" dia. headed studs	2at7.5	1	18	B8-S1
			2	36	B8-S2
			3	66	B8-S4
B9	3/4" dia. headed studs	2at15	1	18	B9-S1
			2	42	B9-S3
			3	72	B9-S5

Note: All specimens were loaded on the top of the slab.

TABLE 2

Cylinder Strengths of Concrete in Beam Slabs and Pushout Specimens

Cylinder No.	Age at Test (days)	Strength (psi)
1	22	3000
2	22	2990
3	22	3075
4	25	3120
5	25	3020
6	25	3175
		Ave 3063 psi
7	35	3242
8	35	3230
9	35	3460
10	35	3210
11	42	3500
12	42	3360
	Average of cylinders 7 to 12	3337 psi

Note: The ave. of cylinders 7 to 12 was used in calculating the plastic moment for the beam specimens. These cylinders were the ones taken directly from the beams as poured and were tested on the same day as the respective beam tests.

TABLE 3

Static Yield Strength of Material in 12WF27

Coupon No.	Material	Location of Coupon	Static Yield Stress (ksi)	Ultimate Stress (ksi)	Modulus of Elasticity E (ksi)
1	ASTM A7 Structural	Flange	37.3	64.8	31.6
2		Flange	37.4	63.8	31.1
		Ave.	37.35		
3		Web	42.0	66.2	29.2
4		Web	41.7	66.0	30.7
		Ave.	41.85		

Average values used in caluclations

f_y = 37.0 ksi (flange

f_y = 42.0 ksi (web)

TABLE 4

Coupon Tests of Connector Material

Specimen	Connector Material	Type of Coupon	Static Yield Stress (ksi)	Ultimate Strength (ksi)	Modulus of Elasticity E (ksi)
1	1/2" dia.L studs and 1/2" dia. headed studs	Tension	58.4	66.9	30.6×10^3
2	"	Tension	59.4	67.7	30.6
3	3/4" dia. headed studs	Tension	62.5	76.2	29.1
4	"	Tension	61.5	75.4	29.6

Note: Specimens 1 and 2 - 1/2" dia. plain round bar

Specimens 3 and 4 - ASTM E 8 - 54 T coupon

TABLE 5

Double Shear Tests of Connector Material

Specimen No.	Material*	Stud Type	Ultimate Shear Load (lbs)	Ultimate Shear Stress (psi)
1	C1010-C1017	1/2" L	17,740	45,300
2	"	1/2" L	17,540	44,700
3	"	1/2" headed	17,460	44,500
4	"	1/2" headed	17,600	44,900
5	C1015-C1017	3/4" headed	42,400**	49,800
6	"	3/4" headed	42,750**	50,000

* Material designations are those of the American Iron and Steel Institute.

** Area = 0.426

The specified properties of the stud material are as follows:

1/2" L

Tensile strength - 72,000 psi min.

Yield strength - 61,000 psi min.

Elongation - 20% (2" gage length)

3/4" headed

Tensile strength - 65,000 psi min.

TABLE 6

Summary of Beam Test Results

Specimen	Test	Load Spacing 2b (in.)	Failure Type	C_L Moment M (k-in.)		Connector Force Q (kips)	Max. End Slip at P_u (in.)	Residual End Slip (in.)
				M_p	M_u			
B7	B7-S1		(A)	2712	2430	12.6	0.059	0.046
B8	B8-S1	18	(A)	2712	2542	13.2	0.035	0.030
B9	B9-S1		(A)	2712	2510	23.8	0.040	0.029
B7	B7-S2	36	(C)	2712	2478	14.05	0.139	0.206*
B8	B8-S2	36	(A)	2712	2558	14.5	0.063	0.053
B9	B9-S3	42	(A)	2712	2498	28.4	0.039	0.027
B8	B8-S4	66	(C)	2712	2415	17.2	0.129	0.361*
B9	B9-S5	72	(B)	2712	2438	34.7	0.198	0.380

Failure Type (A) Test stopped short of crushing of slab

(B) Failure to carry additional load

(C) Cursching of concrete slab

* After connector failure

TABLE 7

Summary of Pushout Test Results

Specimen	Connector Type	Ultimate Connector Force QF (kips)	Shear Stress* (ksi)	Type of Failure	Remarks
P7	1/2" dia. L stud	6.75	34.4	Shearing of studs	No cracks in slab
P8	1/2" dia. headed stud	12.1	61.8	Shearing of studs	No cracks in slab
P9	3/4" dia. headed stud	16	36.3	Shearing of studs	Large cracks in slab

*Computed on the basis of a uniform distribution of shear stress on the cross section of the connector.

TABLE 8

Comparison of Beam Tests and Pushout Tests

Specimen	Connector Force Q_F (kips)	Manner of Failure	$\frac{Q_{Beam}}{Q_{Pushout}}$
B7	B7 = 14.05	crushing of concrete slab	
	P7 = 6.75	shearing of studs	$Q_{B7}/Q_{P7} = 2.08$
	P1 = 11.0	shearing of studs	$Q_{B7}/Q_{P1} = 1.28$
	P4 = 10.4	shearing of studs	$Q_{B7}/Q_{P4} = 1.35$
B8	B8 = 17.2	crushing of concrete slab	
	P8 = 12.1	shearing of studs	$Q_{B8}/Q_{P8} = 1.42$
	P5 = 12.1	shearing of studs	$Q_{B8}/Q_{P5} = 1.42$
	P6 = 12.1	shearing of studs	$Q_{B8}/Q_{P6} = 1.42$
B9	B9 = 34.7	failure to carry additional load	
	P9 = 16.0	concrete failure	$Q_{B9}/Q_{P9} = 2.17$
	P3 = 21.2	concrete failure	$Q_{B9}/Q_{P3} = 1.68$

Note

$$\frac{Q_{P5}}{Q_{P1}} = \frac{12.1}{11.0} = 1.10$$

$$\frac{Q_{B8}}{Q_{B3}} = \frac{17.2}{15.3} = 1.12$$