BOLTED CONNECTIONS FOR PRECAST R.C. PANELS USED FOR REPAIR AND/OR STRENGTHENING

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SUMMARY

The present study deals with bolted type of connectors and evaluates their behavior through an experimental study on ten models. Models used in the tests consist of a pair of 3 cm. thick reinforced concrete panels which are attached to two 75 cm. long r.c. beams at the top and bottom.

Standard steel angles, plates and bolts are used as the connecting elements.

Tests results are encouraging towards the use of such panels in repair and/or strengthening of existing structures under lateral loads.

INTRODUCTION

Multiple precast r.c. panels have proven to be very effective and economical in repair and/or strengthening of damaged building structures (Refs. 1 and 2). The panels can easily be inserted and connected inside the existing frame openings, thus repair time is reduced. Both welded or bolted type of connectors can be used. A special welded type has been developed by the author and reported (Ref. 3). The present study is involved with bolted type of connectors only.

EXPERIMENTAL PROGRAM

Altogether ten models were prepared and tested to study the behavior of some selected types of bolted connections. Two reinforced concrete beam elements measuring (15 cm x 15 cm x 75 cm) and two precast r.c. panels measuring (30 cm x 60 cm x 3 cm) were assembled to form the precast model. Out of ten models, two were cast monolithically. A concrete mix was designed to yield a nominal compressive strength of $f_c' = 200 - 225\ kg/cm^2$. Main reinforcement of the beam elements consisted of 8 mm. Straight bars (average yield stress $f_y = 4170\ kg/cm^2$) and the panels contained 6 mm straight bars (average $f_y = 5367\ kg/cm^2$). The reinforcemnet details are given in Fig. 1.

Models M1 and M6 were cast monolithically. In the remaining precast models, the connection materials consisted of mainly standard steel angles, steel plastes, wedge anchors and regular bolts. Different connection patterns are illustrated in Fig. 2. The details of each connection are given in Fig.3.

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The models were positioned inside the steel loading frame as shown in Fig. 4. They were fixed to the loading frame by means of screw jacks and the two side supports. Rollers were used at the top to constrain the vertical displacements and to allow only horizontal displacements.

The load was applied horizontally along the top beam by means of a hydraulic jack and dial gages were used to measure the corresponding displacements (Fig. 4). One-way loads were applied to Models M1 thru M5, and two-way loads (repeated and reversed) to Models M6 thru M10. Two-way loading consisted of two cycles (Cycle 1 : $\mp$ 2270 kg, Cycle 2 : $\mp$ 3640 kg) followed by loads up to failure.

EXPERIMENTAL RESULTS

The load-displacement curve of Model 7 is given as an example (Fig. 5).

The values of initial stiffness, maximum loads and maximum displacements, dissipated energies and the failure modes are given in Table 1. The load-displacement envelope curves are given in Fig. 6.

TABLE 1 : EXPERIMENTAL RESULTS (Ref. 4)

Model No	Panel concrete f'_c (kg/cm^2)	Type of loading	Initial stiffness K_1 (kg/cm)	Max. load P_{max} (kg)	Max. Displ. Δ_{max} (cm)	Dissipated energy E (kg/cm)	Type of Failure
M1	228	one-way	4000	4800	1.80	3.646	SC Sudden
M2	187	"	769	2500*	3.50*	4.375*	R-Cr
M3	247	"	2222	5300	3.55	9.884	SC Delayed
M4	324	"	2500	5450	2.65	7.364	SC Sudden
M5	200	"	1818	3400	4.05	8.046	R-Cr
M6	217	two-way	4000	4800	2.50	9.045	SC Sudden
M7	225	"	1111	6400	7.30	26.545	R-Cr
M8	249	"	2000	7500	4.70	16.932	SC Delayed
M9	207	"	1428	7300	3.60	7.839	SC Sudden
M10	203	"	1818	2800	3.00	3.943	R-Cr

SC = Shear Compression Failure; R-Cr = Rotation - Crushing Failure.

(*) = Incomplete Test Results.

CONCLUSIONS

Within the scope of the limited number and scaled models tested, following conclusions were reached:

i) More effort and precision are required to assemble the proposed bolted type of connections when compared to welded types (Ref. 3),

ii) The initial stiffness of precast models (M2-M5, M7-M10) are almost half as much as of monolithic models (M11, M6),

iii) All the connection elements and bolts help to dissipate most of the input energy,

iv) Connection of the precast panels to the beam elements by means of steel angles and bolts has a positive effect on the load carrying capacity when compared to models (M5, M10) where load is transferred to the panels by means of shear keys,

v) As an outcome of this comparative experimental study, the detailing used in models M3 and M8 (continuous plate connection between panels, steel angle connection between panels and beams) is suggested for a further full-scale testing and analytical study.

ACKNOWLEDGEMENTS

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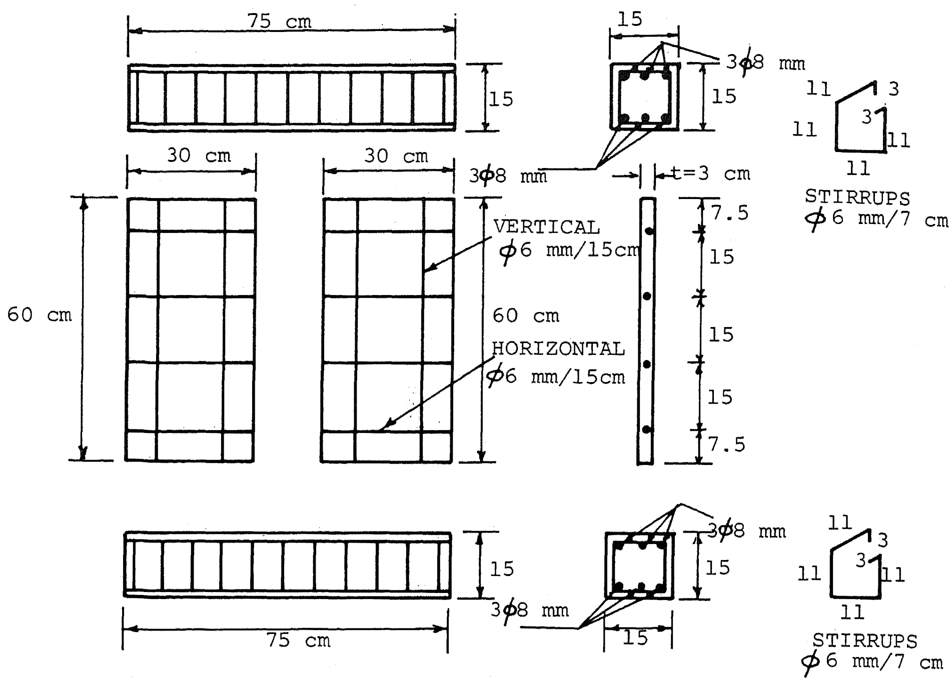

Fig. 1 : Reinforcement detail (M2,M3, M4, M5, M7, M8, M9,M10)

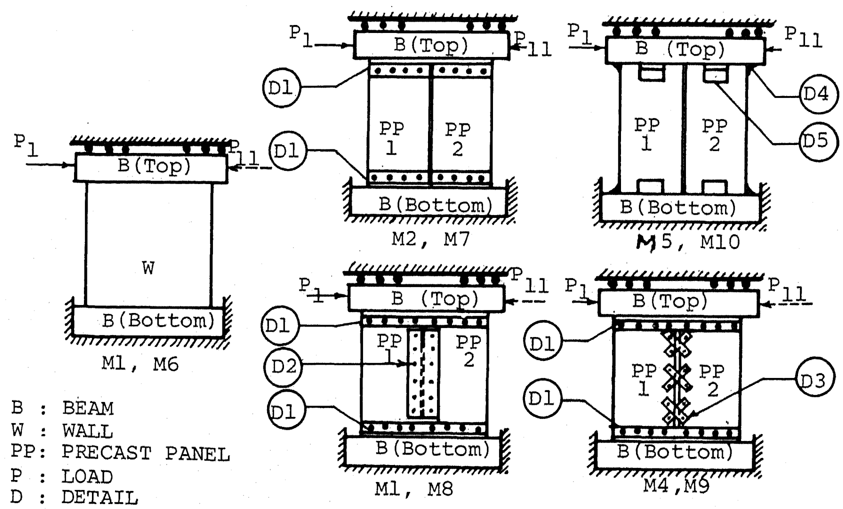

Fig. 2 : Connection patterns

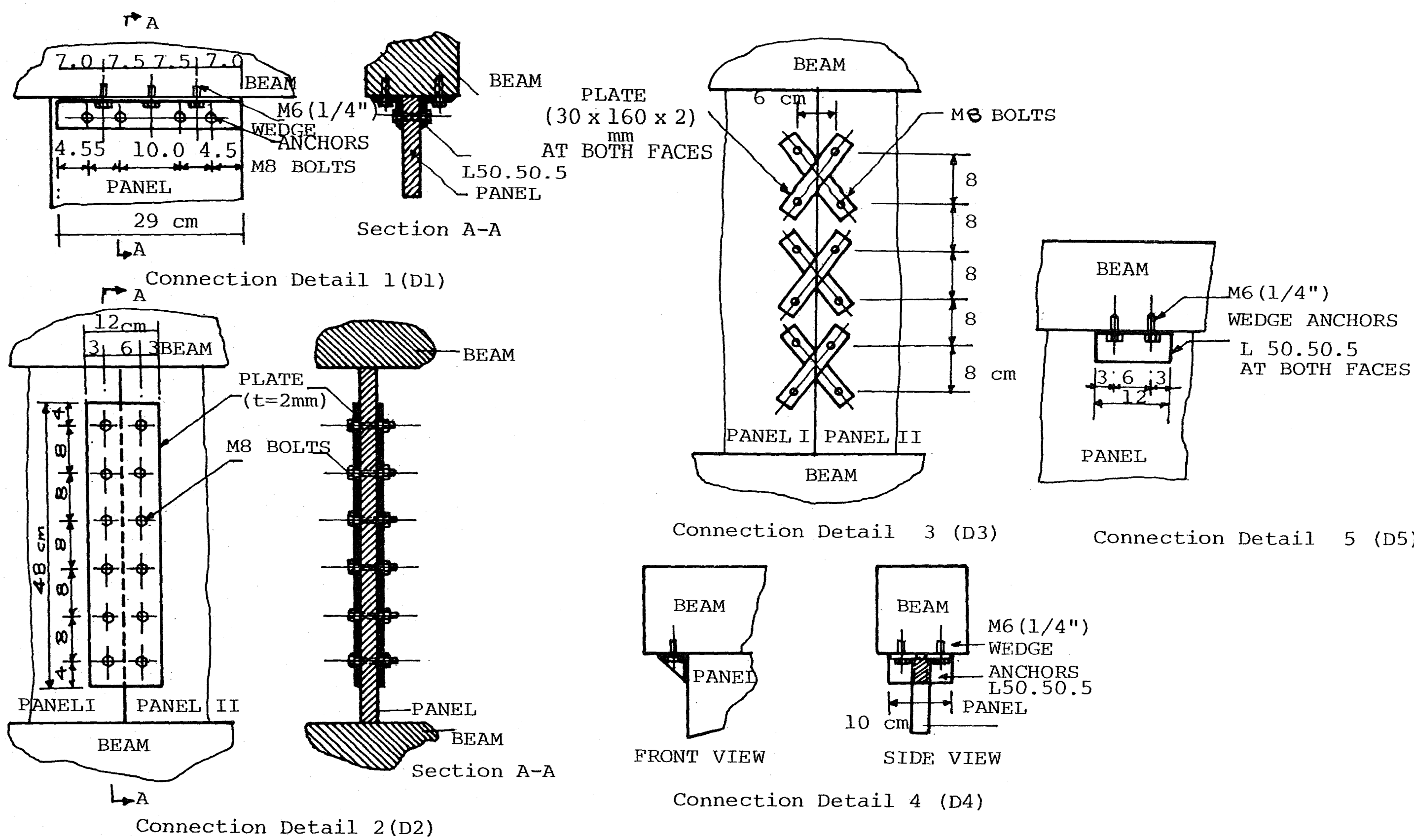

Fig. 3 : Connection Details

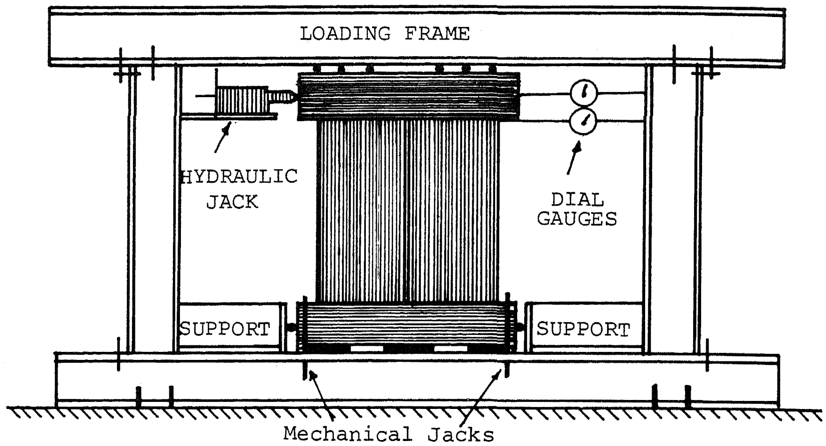

Fig. 4 : Experimental set-up

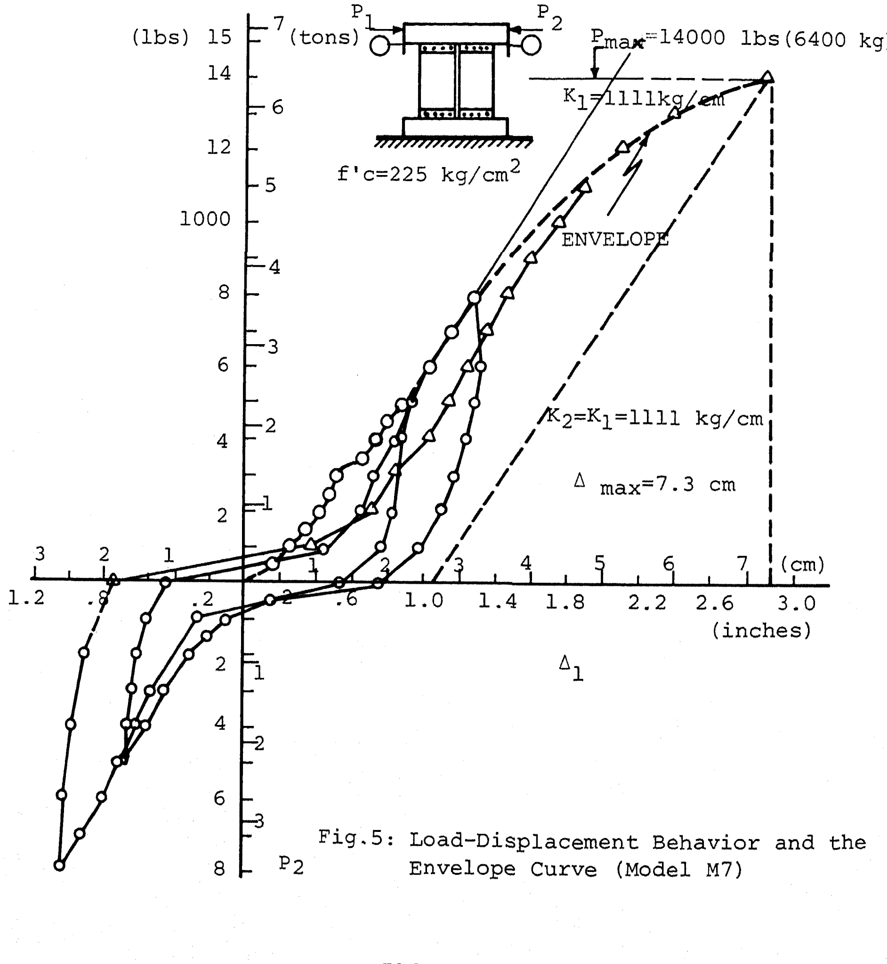

Fig.5: Load-Displacement Behavior and the Envelope Curve (Model M7)

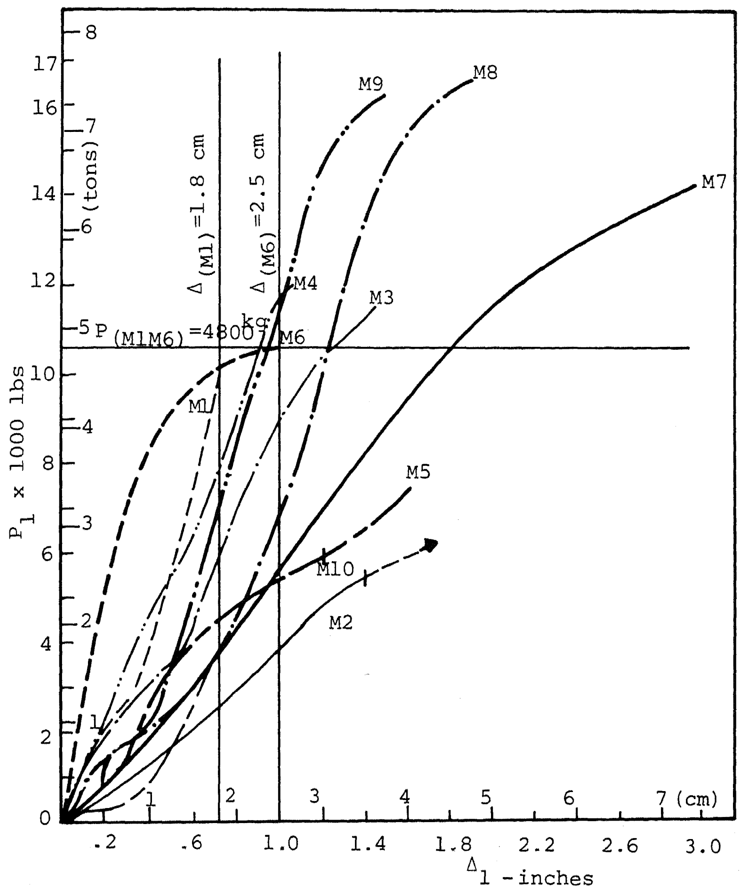

Fig. 6 : General Comparison of Behavior