

SESSION 5D Earthquake Resistant Design

REINFORCED CONCRETE H-FRAMES, Most Suitable for Earthquake Construction

by

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On the occasion of a visit to the University of California in Berkeley in March this year, I had the opportunity of getting acquainted with special earthquake research which showed that a monolithic frame connection between reinforced concrete columns and beams seems most suitable to resist earthquake forces.

At the last World Conference in Santiago in 1971 it was pointed out in a paper "Lessons from some recent Earthquakes in Latin America" by the National University of Mexico that "careless detailing of joints was responsible for heavy damage". Reference may also be made to a paper by Dr. C. Corley and Norman Hanson in which tests on a "Design of Beam-Column Joints for Seismic Resistance in Reinforced Concrete Beams" were reported. Further research results were shown in Sessions 1C and 2D, and special reference is made to the presentations by Professors Popov, Bentoro and Bowcamp of the University of California and Dr. Paulay of the University of Christ Church.

In this connection I should like to show a design developed by the firm of Consulting Engineers, Jan Bobrowski and Partners of Twickenham, England, and Calgary, Canada, before I became their Consultant in 1969. This comprises precast H-frames according to Figure 1. Steel shoes with locating dowels are welded to the main reinforcement of the top and bottom ends of the columns and to the ends of the beams respectively.

(1) Consultant with Jan Bobrowski and Partners, Calgary (Canada) and Twickenham (England)

This method was initially devised in order to ensure the accuracy of alignment combined with increase in speed of erection and has been satisfactorily used at numerous constructions. Obviously it would very well apply to earthquake constructions provided the design conforms with the research results relating to earthquake resistance. The corresponding steel shoes are welded together at the site and tests relating to the resistance of the welded connections to horizontal forces have proved very satisfactory. Obviously these welded connections can also be adjusted to resist impact forces as they occur at earthquakes. The very satisfactory use of the precast H-frames according to the designer, Bobrowski, shows that good design and construction seems to be useful for many purposes and uses. This system was introduced by Bobrowski as early as 1961.

The following Figures 2 and 3 illustrate the application at one example built in 1971/2, i.e. at the Editorial and Administrative Building of the Surrey Mirror at Redhill, which also included the possibility of type-setting for some twenty different local newspapers. The building, of dimensions 12.3 x 30.3 m, comprised storey high H-frames of 10 tons weight, spaced at 4.88 m, made of lightweight concrete (Solite) of a strength of 52 N/mm^2 (7,500 psi).

After completion of the piling and pile caps, the precast structure of walls, floors, staircases, cladding and asphalt roof was completed in 27 working days. The window cill panels, 1.85 m deep, were cast integrally with the structural H-frames, as seen in the slides.

Figures 4, 5 and 6 refer to the Calgary Exhibition and Stampede Grandstand being built 1973/4. Here large H-frames and H-frame elements in lightweight concrete of weight 30-50 tons are used.

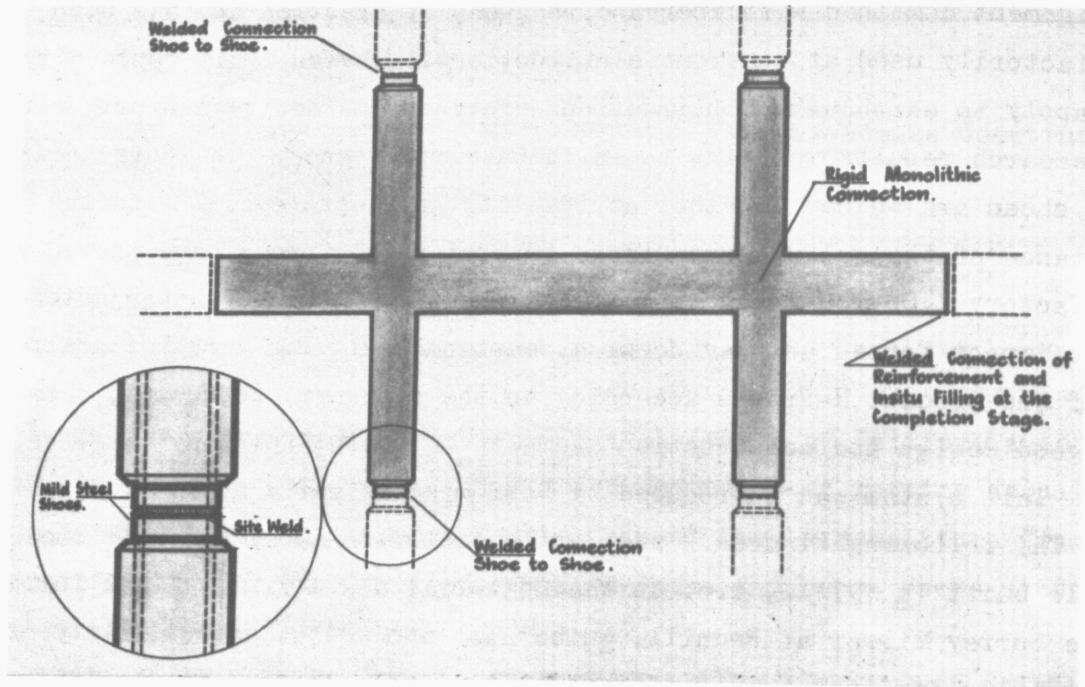


Figure 1.

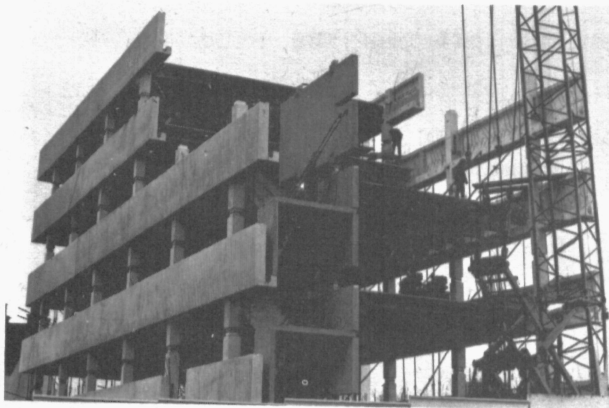


Figure 2.

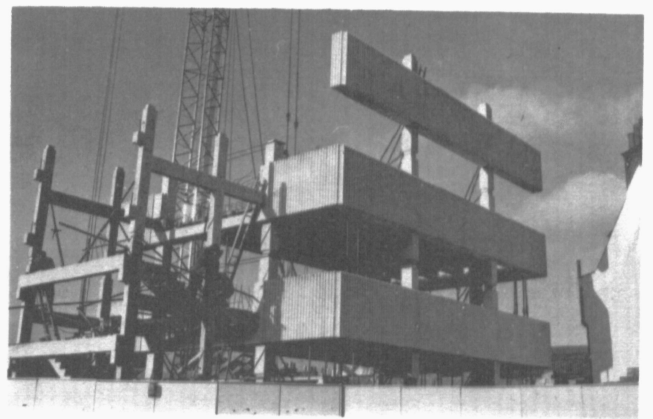


Figure 3.

Surrey Mirror, Redhill, England

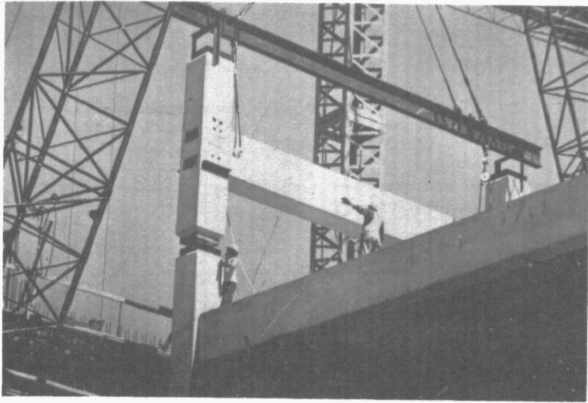


Figure 4.

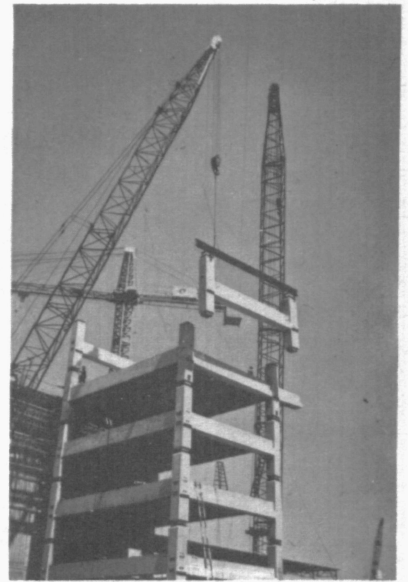


Figure 5.



Figure 6.

Calgary Exhibition and Stampede Grandstand, Calgary, Canada