Annotated bibliography on reinforced concrete brackets

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ON REINFORCED CONCRETE BRACKETS

compiled by

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INTRODUCTION

This bibliography was prepared as part of a study of joints in precast concrete structures. In many instances of beam-to-column or beam-to-beam connections the beam is seated on a bracket on the supporting member. Criteria for the design of such brackets did not appear to be readily available and as a preliminary to initiating research into the problem a literature search was made to determine what information or research results had already been published.

A complete search was made of DBR's technical library. The principal sources covered were: The Engineering Index, 1928 to 1962 inclusive, published by Engineering Index, Inc., New York; Comprehensive Bibliography of Cement and Concrete, 1925-1947 by Floyd O. Slate, Lafayette, Indiana, Purdue University, 1951; The American Concrete Institute 55-Year Index, 1905-1959 and subsequent Proceedings, A. C. I. Publication 1960, U. S. A.; British Research Station Library Communications of Translations from No. 1 to 900; The Reinforced Concrete Review, 1945-1961, the Journal of the Reinforced Concrete Association, London; Magazine of Concrete Research No. 1 to 40, 1949 to 1962, published by the Cement and Concrete Association; The American Society of Civil Engineers Publications through the ASCE indexes, 1900-1959, published by The Society in New York.

The American Concrete Institute, Detroit, Michigan, and the Portland Cement Association, Skokie, Illinois were written for references on this subject.

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1. Apple, R.E. Reinforced Concrete Column Bracket Tests. Austin, Texas, Thesis, University of Texas, Dept. of Civil Engineering, June 1952, 55p.

This thesis deals with the load testing of a bracket. The author chose a bracket typical of those in actual use and suitable for testing with the laboratory facilities available. The study is mainly concerned with the load-carrying capacity and manner of failure of the bracket. The test was exploratory and no design procedure can be recommended. Results are compared with theory, noting that both the "prismatic beam formula" for shear and the "wedge shaped beam theory" produce very conservative design values.

2. Billig, K. Precast Concrete. New York, Van Nostrand, 1955, p. 108, 109, 161, 181, 183, 185, 189, 225, 231, 238, 252, 256, 260, 262.

Descriptions of brackets, their uses, recommendations regarding details and general discussion are given. The author favours the use of brackets for joints because of their simplicity, ease of construction and their separation of the load resisting elements of a joint. Thus by the provision or omission of moment resisting elements, joints embodying brackets can be varied from fully continuous to simply supported.

The author states that brackets must be heavily reinforced because of impact loads during erection. No method is suggested for the analysis of stresses in brackets, nor is the design method given.

3. Bray, T.J. A Course of Reinforced Concrete Design. Third ed. rev., London, Chapman and Hall, 1960, p. 95-97.

Moments in columns caused by eccentric or bracket loads are discussed briefly. The author states that the maximum column

moment in bending occurs at the bracket (depth assumed to be negligible); and that the moments vary according to the height at which the bracket is placed.

Three cases are considered concerning moments in columns:
(1) columns free at both ends;
(2) columns fixed at both ends;
(3) columns fixed at one end and free at the other.

4. Collins, F.T. Manual of Tilt-up Construction. Fourth ed., Eugene, Ore., Know How, 1958, p. 53-64.

There are good examples of joinery using brackets, but no details of bracket design are given.

5. Portland Cement Association. Concrete for Industrial Buildings and Garages. Sec. ed. Chicago, 1946.

Floor framing is described with regard to standard column caps, but this publication does not deal with the design of special brackets. The article shows examples of brackets used to support crane rails but does not describe them in detail.

The authors go on to explain provisions that must be made to allow for the extension of buildings in the future. Brackets are located on the temporary end columns as illustrated.

6. Davey, N.E. Bonding New Concrete to Old. Great Britain, Department of Scientific and Industrial Research, Building Research Station, Bulletin No. 9, 1936, 4p.

This report contains one paragraph dealing with brackets cast with columns, and tells when they should be cast with respect to time of casting columns.

7. Dunham, C.W. Theory and Practice of Reinforced Concrete. New York, McGraw-Hill, Sec. ed., 1944.

The author illustrates a problem in the design of the reinforcement for a column bracket. He contrasts the two cases of length to depth ratios of the bracket with design theory.

8. Hogg, A. D. and A. F. Beer. Improved Reinforcement of Short Concrete Brackets. Ontario Hydro Research News, Vol. 9, No. 3, July-Sept., 1957, p. 27-30.

A review of theoretical studies on the design of reinforced concrete brackets. If standard formulae are used the conventional configuration of reinforcing steel does not help a great deal in reinforcing for diagonal tension. A new configuration is suggested.

Model tests to prove the theory are described. Pairs of brackets are used, to reinforce conventionally, the other to take care of the diagonal tension.

These tests confirmed the theoretical analysis, but the paper does not recommend design rules.

9. Hool, G. A. and W. S. Kinne, eds. Reinforced Concrete and Masonry Structures. New York, McGraw-Hill, 1944, p. 263-265.

Column brackets supporting crane runway girders should be designed for the most severe conditions of loading possible and should have such a depth as to keep the shear on the effective section below 0.03 f'_c.

The authors point out that various tests were made on column brackets that led to development of a method of reinforcing them properly. This is illustrated by a design problem.

10. Naslund, K. C. Precast Concrete Joinery - Basic Design Principles. Architectural Record, June, 1961, p. 166-169.

The author discusses different types of connections and deals with brackets as a shear connection. He recommends certain procedures to follow when designing a bracket but goes into no detail.

11. Prahl, G. Construction of Single-storey Industrial Buildings with Precast Reinforced Concrete Members. (From Betonstein Zeitung, Vol. 23, No. 2, Feb. 1957.) London, Cement and Concrete Association. Library Translation No. 68, 1957.

This article shows many photographs of precast columns with brackets but no description is given regarding their design, nor are details of bracket dimension and reinforcement shown.

12. Richart, F.E. Tests of the Effect of Brackets in Reinforced Concrete Rigid Frames. Bureau of Standards, Journal of Research, Vol. 1, July-Dec., 1928, p. 189-253.

This paper is concerned with the design of brackets as they affect the whole frame. Results of analyses and tests of rigid frames of reinforced concrete with and without brackets are given. The lengths of the brackets varied and the author relates size of bracket to moment.

An empirical expression for the moment of inertia for use in determining the distribution of moments has been developed. Throughout the paper comparisons of the test results with the simplified equation are shown.

The author feels that the extent of his test is insufficient to recommend a design procedure.

13. Cement and Concrete Association. Single Story Industrial Buildings. Rev. ed., London, April 1960, p. 17, 18, 23, 25, 26, 30.

This publication is a descriptive commercial booklet showing many pictures of brackets, but it fails to describe their design.

14. Stanovsky, J.J. Strain Measurements in Reinforced Concrete Column Brackets. Thesis, University of Texas, Austin, Texas, 1952.

The author was concerned on this test with Apple (Ref. 1). The strain distribution in reinforcing bars caused by different loadings at different eccentricities was studied. Results are compared with theory, again showing that the rectangular beam formula for shear produces conservative results. Conclusions indicate that before an adequate bracket design can be reached many more tests must be performed.

15. The Hydro-Electric Power Commission of Ontario, Research Division. Stresses Occurring in Short, Reinforced Concrete Brackets. Report No. 57-148, March 29, 1957.

This paper describes tests to determine the shear stress in reinforced concrete brackets by theoretical, photo-elastic and concrete model experiments.

The authors state that little literature exists concerning the design of brackets, especially in determining the magnitude of the allowable shear stress to be used with various length-to-depth ratios.

A description is given of a design in agreement with the A. C. I. Code, providing that the bracket is designed as a cantilever beam.

Two series of tests were performed (for small and large brackets) and the brackets were loaded to failure.

The authors describe the design procedure and certain recommendations concerning the arrangement of the reinforcing steel.