

FRITZ ENGINEERING
LABORATORY LIBRARYTASK REPORT TO COLU~~M~~ RESEARCH COUNCIL

1. COLUMNS IN CONTINUOUS FRAMES
2. INELASTIC LATERAL-TORSIONAL BUCKLING OF BEAM COLUMNS

by

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Lehigh UniversityINTRODUCTION

Research in the areas of work delineated by CRC as the task reports from Lehigh University on (1) Columns in Continuous Frames and (2) Inelastic Lateral-Torsional Buckling of Beam-Columns consisted mainly of filling in gaps in previously obtained information. No new research was started in these two areas in the past year.

The main objectives of the research on beam-columns have been accomplished. It has been shown that the behavior of beam-columns bent about one of the principal axes of the wide-flange cross section can be theoretically predicted. Good correlation has been shown to exist between these predictions and experimental results.

The work this year consisted of generating graphs and charts which are needed for the design of columns in planar multi-story frames. In addition, a report was prepared summarizing the results of the research on the inelastic lateral-torsional buckling of steel wide-flange beam-columns. In this report it is shown that the inelastic critical stress can be estimated by computing first the elastic critical stress which is then reduced to its inelastic value by the CRC Basic Column formula. This procedure has been recommended for beams in the CRC Guide, and it has now

been shown that it also applies to beam-columns.

Since the work on the behavior of individual beam-columns has been in progress for nearly 30 years at Lehigh, and since it is now nearing completion, it might be desirable to provide a brief summary of this research. This summary will be in a form of a list of references. The results of so much work could not be collected briefly in another form, and it is hoped that this list will assist the column researchers who are carrying this work on further into problems of biaxial bending and frame behavior.

PHASES OF THE WORK

The research on the inelastic instability of beam-columns at Lehigh University can be roughly categorized as follows:

1. Studies of the moment-curvature-thrust relationship
2. The strength of beam-columns deforming only in the plane of the applied moments.
3. Lateral-torsional buckling
4. Beam-column tests
5. Restrained columns

LIST OF REFERENCES

Following are the references which describe the research. These references include mainly published reports. Some other reports, which are not yet published, but which have been submitted for publication (or will be submitted in the near future) are also included.

1. Studies of the Moment-Curvature-Thrust Relationship

These studies provide methods for determining curves and formulas which relate the moment, the thrust and the resulting curvature

for wide-flange cross sections bent about the major or the minor axis. The significant contribution of this work is the inclusion of the effect of the residual stresses. M-P- ϕ relationships are the basic building blocks from which much of the following work is built up.

A. W. Huber, L. S. Beedle

RESIDUAL STRESS AND THE COMPRESSIVE STRENGTH OF STEEL
The Welding Journal, Vol. 33, 1954

R. L. Ketter, E. L. Kaminsky, L. S. Beedle

PLASTIC DEFORMATION OF WIDE-FLANGE BEAM-COLUMNS
Trans. ASCE, Vol. 120, 1955

M. G. Lay, N. Gimsing

EXPERIMENTAL STUDIES OF THE MOMENT-THRUST-CURVATURE RELATIONSHIP
Welding Research Supplement of the Welding Journal, Vol. 49,
Feb. 1965

2. The Strength of Beam-Columns Deforming only in the Plane of the

Applied Moments

The "in-plane" strength of a beam-column is the maximum combined end moment and axial force which can be sustained. It is determined by integrating the moment-thrust-curvature relationship along the length of the member.

R. L. Ketter

THE STABILITY OF BEAM-COLUMNS ABOVE THE ELASTIC LIMIT
Proc. ASCE, Vol. 81, No. 692, 1955

R. L. Ketter

THE INFLUENCE OF RESIDUAL STRESS ON THE STRENGTH OF STRUCTURAL MEMBERS
WRC Bulletin No. 44, 1958

A. W. Huber, R. L. Ketter

THE INFLUENCE OF RESIDUAL STRESS ON THE CARRYING CAPACITY OF ECCENTRICALLY LOADED COLUMNS
Proc. IABSE, Vol. 18, 1958

R. L. Ketter, T. V. Galambos

COLUMNS UNDER COMBINED BENDING AND THRUST, Trans. ASCE, Vol. 126,
Part I, 1961

T. V. Galambos, J. Prasad
ULTIMATE STRENGTH TABLES FOR BEAM-COLUMNS
WRC Bulletin No. 78, July 1962

3. Lateral-Torsional Buckling

Unbraced beam-columns may fail by lateral-torsional buckling before the maximum "in-plane" strength is reached. In the following reports a tangent modulus solution is presented for determining the critical moments of beam-columns:

- T. V. Galambos**
INELASTIC LATERAL BUCKLING OF BEAMS
Proc. ASCE, Vol. 89 (ST 5) 1963
- T. V. Galambos, Y. Fukumoto**
INELASTIC LATERAL-TORSIONAL BUCKLING OF BEAM-COLUMNS
Fritz Laboratory Report No. 205A.34, Aug. 1963
- T. V. Galambos, P. F. Adams, Y. Fukumoto**
FURTHER STUDIES ON THE LATERAL-TORSIONAL BUCKLING OF STEEL
BEAM-COLUMNS
Fritz Laboratory Report No. 205A.36, Feb. 1965

4. Beam-Column Tests

The theoretical studies have been supplemented by tests on full sized beam-columns. The following reports contain an account of these tests:

- B. G. Johnston, L. Cheney**
STEEL COLUMNS OF ROLLED WIDE-FLANGE SECTION
AISC Research Reports No. 190 and 191, Nov. 1942
- L. S. Beedle, J. A. Ready, B. G. Johnston**
TESTS OF COLUMNS UNDER COMBINED THRUST AND MOMENT
Proc. SESA, Vol. VIII, No. 1, 1950
- R. L. Ketter, L. S. Beedle, B. G. Johnston**
COLUMN STRENGTH UNDER COMBINED BENDING AND THRUST
The Welding Journal, Vol. 31, 1952
- R. C. Van Kuren, T. V. Galambos**
BEAM-COLUMN EXPERIMENTS
Proc. ASCE, Vol. 90(ST 2), April 1964
- T. V. Galambos, M. G. Lay, R. Aglietti**
TESTING TECHNIQUES FOR RESTRAINED BEAM-COLUMNS
Fritz Laboratory Report No. 278.7, Oct. 1963

M. G. Lay, T. V. Galambos
TEST ON BEAM AND COLUMN SUBASSEMBLAGES
Fritz Laboratory Report No. 278.10, June 1964

5. Restrained Columns

Beam-columns are not isolated members but they form part of a frame. They are thus not only loaded but also restrained by members which connect to their ends. The study of restrained columns is summed up in the following list of reports:

- M. Ojalvo
RESTRAINED COLUMNS
Proc. ASCE, Vol. 86 (EM 5), 1960
- M. Ojalvo, Y. Fukumoto
NOMOGRAPHS FOR THE SOLUTION OF BEAM-COLUMN PROBLEMS
WRC Bulletin No. 78, June 1962
- M. G. Lay
THE MECHANICS OF COLUMN DEFLECTION CURVES
Fritz Laboratory Report No. 278.12, June 1964

CURRENT RESEARCH

At present research is concerned with problems related to the local buckling of high-strength steel beam-columns.

Respectfully Submitted to the
Column Research Council

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