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The basic column formula, Technical Memorandum No. 1, May 1952

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The Column Research Council will issue from time to time such information as it considers firmly established by theory and test. Information so released will be considered by Column Research Council to be of such basic importance as to warrant widespread adoption in setting up column specifications.

TECHNICAL MEMORANDUM NO. 1
May 19, 1952
THE BASIC COLUMN FORMULA

The Column Research Council has brought out that it would be desirable to reach agreement among engineers as to the best method for predicting the ultimate load-carrying capacity in compression of straight, prismatic, axially loaded, compact members of structural metals. It was proposed that Research Committee A of the Council be assigned the problem of reporting on the correctness and desirability of the tangent-modulus column formula. This formula involves simply the substitution of the tangent modulus, $E_t$, for $E$ in the Euler Formula. This formula may be written,

$$ \frac{P}{A} = \frac{\pi^2 E_t}{(\frac{K L}{P})^2} $$

where $P =$ the ultimate load (lb.),

$A =$ the cross-sectional area (Sq.in.),

$E_t =$ the compressive tangent modulus (slope of the compressive stress-strain curve) of the material...
in the column at the stress $P$ (lb. per sq.in.),

$$r = \frac{\text{least radius of gyration of cross section}}{A},$$

$L = \text{the length of the column (in.)}$

$K = \text{a constant depending on end conditions:}$

- $K = 2$ for one end fixed and the other end free;
- $K = 1$ for both ends simply supported;
- $K = 0.7$ for one end fixed and the other end simply supported;
- $K = 1/2$ for both ends fixed.

For materials which exhibit upper and lower yield points in compression the lower yield point is to be considered as the limiting value $X$ of $P/A$.

Information and reference to literature supporting the foregoing statement will be made available on request to the Secretary of the Column Research Council.

It is the considered opinion of the Column Research Council that the tangent-modulus formula for the buckling strength affords a proper basis for the establishment of working load formulas.

The column formula presented here differs in form from the familiar Euler formula only in that the tangent modulus of elasticity is substituted for the ordinary modulus of elasticity. There is, however, a great practical difference between the two formulas, for, whereas the Euler formula can be solved directly for the average
stress corresponding to any given slenderness ratio, the tangent-modulus formula cannot. It is not the intention to advocate the use of the tangent-modulus formula in design, but rather to propose it as the basis for relating the compressive stress-strain properties of the material to the column strength of the material. The formula furnishes the information for approximating to the average stress in terms of the ratio of slenderness, for any type of centrally loaded column under consideration, by making suitable assumptions with respect to such items as accidental eccentricity, initial curvature of member, residual stresses, and variation in properties of the material.