BEAMS AND GIRDERS: PRACTICAL FORMULAS FOR THEIR RESISTANCE

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RESISTANCE.

BY

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PREFACE.

The main object of this treatise is to deduce general formulas for the resistance of beams and girders applicable to all cases, and to set forth truly "practical formulas," so far as seemingly required, in the use of existing forms and sections. These formulas are shorter and simpler than the corresponding ones in general use, and are, besides, practically perfectly accurate, which is by no means the case, as we have abundantly shown, with the common formulas.

The author is here led to remark that no truly practical formulas on any subject were ever produced except by those having a knowledge of the subject. Nor can there be a truly practical man—one who does things in his calling or profession in the best way—whose practice is not founded upon a personal knowledge of the principles of that calling or profession.

Practice not founded on knowledge is guesswork, and is always awkward, roundabout, and very expensive to those who pay for the guessing. Formulas devised by such "practitioners" are needlessly lengthy and incorrect, and well calculated to consume time and increase expense.

The principal errors in this subject are: 1st. Those arising from the use of erroneous formulas. These amount to 10 or 15%, or even much more in some cases. 2d. Those arising from erroneous estimates of the load coming upon beams, girders, etc. This is usually 12½%, but may be much less, as demonstrated in the text. The loads for given engines and wheel spaces are no doubt sometimes computed. But even then, unless those wheel spaces are such as to produce a maximum load on the beams, which is very improbable, the beams for a different spacing would be liable to a greater load, even up to the maximum, and would therefore be deficient in capacity, though not 12½%.

The combined error is usually not less that 25%, and *on the side of danger.*

Deficiencies due to errors in sizes, or to imperfect workmanship, or to a poor quality of material, do not come within the province of this book.

Numerous applications of the formulas and comparisons with the usual ones are found in the book. The problems in designing are intended as approximate models, and also incidentally to illustrate in a general way the use of the formulas.

Appropriate tables are given for the proportioning of rivets, pins, joists, floor beams, stringers, etc.

The author submits the book to the judgment of the profession, hoping it may be a convenience, and that it may aid in correcting present errors and in avoiding others.

P. H. PHILBRICK.

BEAMS AND GIRDERS:

Practical Formulas for their Resistance.

By practical formulas is meant, those which are both simple and accurate, those which can be easily and safely used.

It is well known that the moment of inertia is a factor in most formulas involving the moment of resistance; and that we usually arrive at the latter through the former. Otherwise we have little interest in the moment of inertia. The moment of resistance, however, does express something fundamentally essential; and the best formulas for the same are therefore very desirable. This will be clear as we proceed.

Accurate formulas for the moment of resistance of all usual sections are well known, but, being more or less complex, and therefore unmanageable by many Bridge Engineers and Architects, other formulas more simple and *seemingly* quite correct, but unfortunately very erroneous, have come into general use.

The main objects of this treatise are:

1°. To deduce and set forth simple and accurate formulas for the resistance of beams, girders, etc.

2°. To point out, to some extent, the errors of the formulas in general use, and the reasons for the existence of these errors.

3°. To apply the new formulas in the examination of existing cases and in designing floor beams, track stringers, etc.

The nature and importance of the moment of resistance will be best understood by first considering the forces that, in ordinary cases at least, produce it. We may then advantageously confine the discussion to the moment of resistance itself.

I. Let *abcd* (Fig. 1) represent a beam fixed at the end *bd* and loaded with a weight W at the free end *ac*. Length of beam $= ab = l$.

It is evident that the fibers on the