

May 27, 1924.

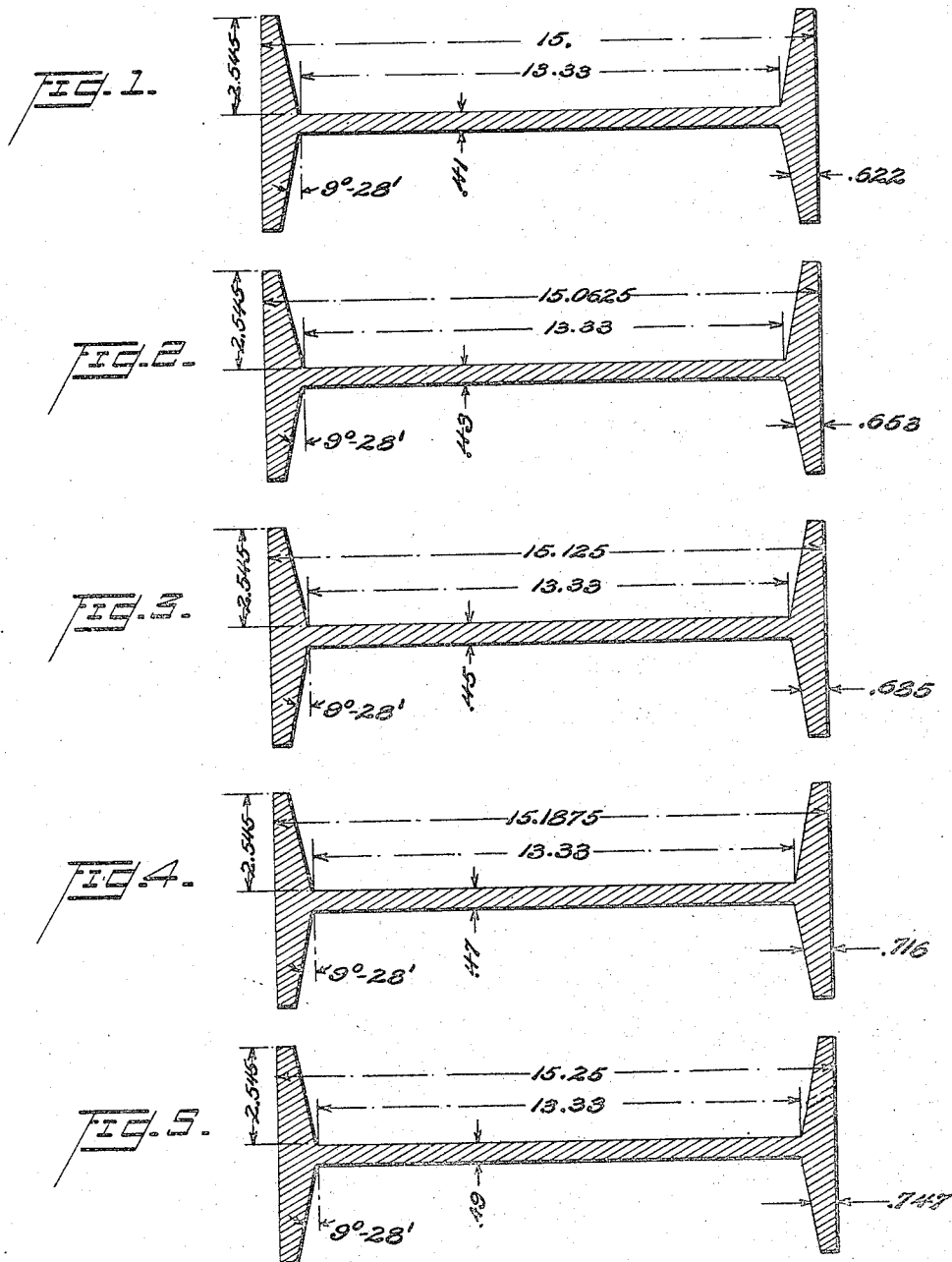
1,495,570

G. H. BLAKELEY

SERIES OF I-BEAMS

Filed April 6, 1921

3 Sheets-Sheet 1



Inventor

G. H. Blakeley,

By Watson, Coit, Morse & Grindle,
Att'ys

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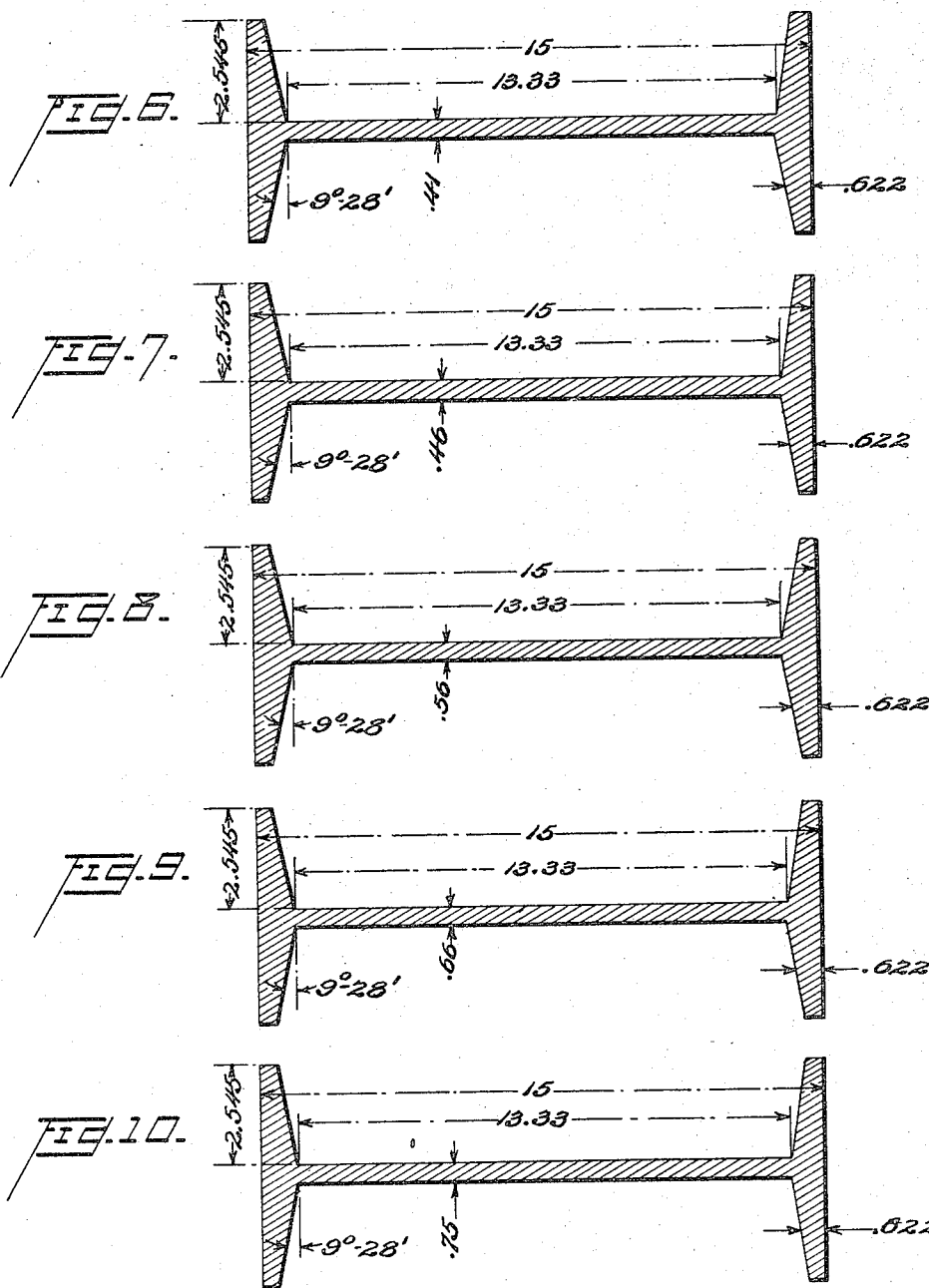
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SERIES OF I-BEAMS

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3 Sheets-Sheet 2



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SERIES OF I-BEAMS

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3 Sheets-Sheet 3

FIG. 11.

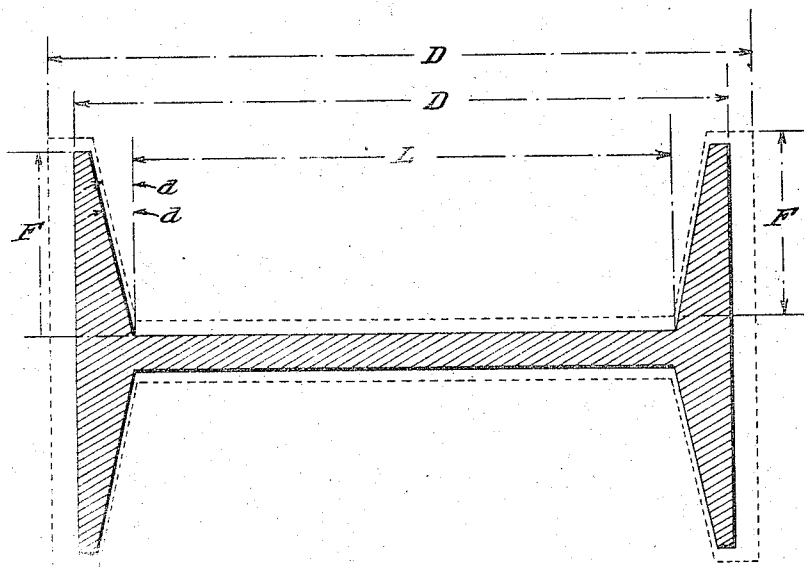
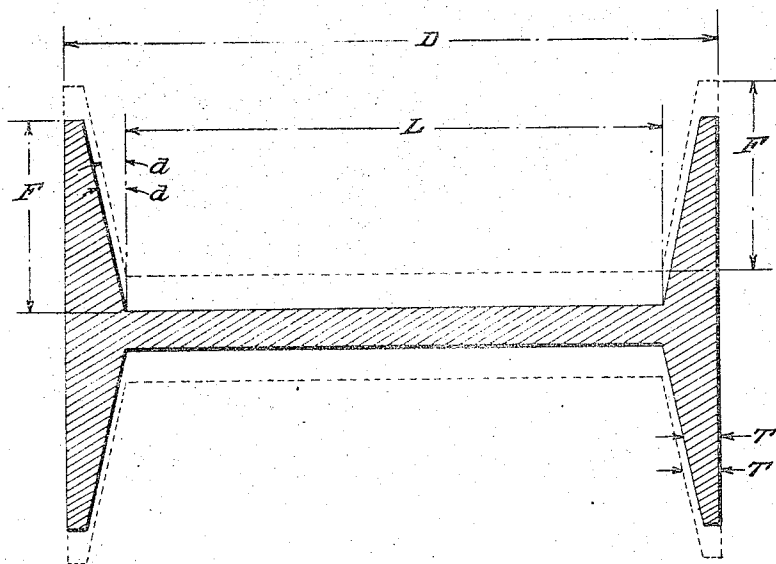


FIG. 12.

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UNITED STATES PATENT OFFICE.

GEORGE H. BLAKELEY, OF BETHLEHEM, PENNSYLVANIA.

SERIES OF I-BEAMS.

Application filed April 6, 1921. Serial No. 458,876.

To all whom it may concern:

Be it known that I, GEORGE H. BLAKELEY, a citizen of the United States, and residing at Bethlehem, Lehigh County, State of Pennsylvania, have invented certain new and useful Improvements in Series of I-Beams, of which the following is a specification.

The present invention relates to rolled I-beams, the principal object being to provide an improved series of I-beams, the heavier beams of the series having a load carrying capacity per unit of weight per foot substantially the same as, or greater than the load carrying capacity of the lighter beams of the series.

Heretofore, a series of standard I-beams, say 15 inch beams, has consisted of a plurality of beams of the same depth, except variations due to the exigencies of manufacture. The beams of the prior series vary in weight from the lightest to the heaviest of the series, the increase in weight being obtained by separating the rolls, thus increasing the thickness of the web and the width across the flanges by the same amount. Hence the only variables in a series of the prior art are the thickness of the web and the width across the flanges. In a series of this kind the strength of the beams per pound per foot of length does not increase as fast as the weight.

In manufacturing beams on standard mills, the rolls wear rapidly so that relatively large tolerances in the dimensions of the finished beams are permitted. Thus a 15 inch beam may be $14\frac{1}{2}$ inches to $15\frac{1}{2}$ inches deep, the tolerances of this particular series being such as to permit a variation of $\frac{1}{8}$ inch under or $\frac{1}{4}$ inch over the nominal size. In other words, when a purchaser obtains a 15 inch beam, it will not necessarily be 15 inches deep but may measure anywhere from $14\frac{1}{2}$ inches to $15\frac{1}{2}$ inches deep.

In a like manner other series of beams may vary in depth within certain other limits.

These variations or tolerances are necessary for practical and commercial reasons. As stated, the rolls are adjusted toward each other in order to decrease the weights of the beams of a series. The amounts by which the rolls are adjusted are unchanged for certain periods of time. During this

time, the rolls wear, so that, whereas the first beam rolled might be $14\frac{1}{2}$ inches deep, a beam rolled near the end of said period might be $15\frac{1}{2}$ inches deep. At the end of the period these rolls are removed to be dressed down and others substituted. If closer tolerances were maintained it would be necessary to shut down the mill at more frequent intervals for the purpose of changing rolls, thereby greatly increasing the cost of manufacture.

It is the aim of the present invention to utilize the aforementioned variation in depth for the purpose of providing another variable in the series of beams; that is to say, in the series of the present invention the depth is also varied within the limit of the tolerances heretofore allowed. For this purpose the beams of my series are manufactured more accurately, the tolerances being cut down to substantially nothing. In other words, a $15\frac{1}{2}$ beam of the present series is as nearly $15\frac{1}{2}$ inches as can be obtained. Hence any beam in a series of the present invention can be used where a beam from the corresponding old series would have been employed. The greater accuracy in rolling may be obtained by finishing the beams on a universal mill.

The present invention therefore comprises a series of I-beams of different weights, in which the ratio of section modulus to weight per foot in a heavy beam is substantially the same as (or greater than) the corresponding ratio in a lighter beam; the depths of the beams of the series increasing progressively from the lightest to the heaviest but the total difference in depth between the lightest and the heaviest beams being relatively small; the section moduli of the beams of the series increasing progressively from the lightest to the heaviest by substantial amounts.

Other objects and features of novelty will be apparent from the description taken in connection with the drawings in which:

Figs. 1 to 5 inclusive are transverse sectional views of a series of five I-beams embodying the present invention;

Figs. 6 to 10 inclusive are transverse sections of a series of four standard I-beams of the prior art;

Fig. 11 is a diagrammatic drawing show-

ing the method now in common use of increasing the sectional areas in a series of I-beams from the minimum to the maximum size;

5 Fig. 12 is a diagrammatic sketch showing the method of increasing the sectional area in my improved series of I-beams from the minimum to the maximum size.

10 The customary fillets at the junctions of the flanges and the webs and the rounding of the inner edges of the flanges have been omitted from the drawings.

In the design of steel structures, when the approximate maximum depth available and the load a beam is to carry are known, it is 15 apparent that as a matter of economy a beam of the greatest depth less than the said maximum and of the lightest weight which will carry the load with safety, should be selected from commercial standards. A 20 series of beams of different weights is therefore provided to permit the architect to select, if practicable, from commercial standards a beam having the load carrying capacity (or section modulus) desired, and 25 still keep within the limit of maximum depth. In all series of I-beams of the prior art, the percentage of increase in weight of the heavier beams over the lighter beams is far in excess of the percentage of increase 30 in load carrying capacity resulting therefrom.

To constitute a "series" of beams as the term series is herein used, all the beams of 35 the group must have a common slope α of inner flange faces and a common dimension L (see Fig. 11); the latter dimension being the shortest distance between inner flange faces measured along the web surface. This 40 requirement is due to considerations of roll economy, all the beams of a given "series" being normally produced on the same or identical sets of rolls. If the above mentioned slope α and dimension L were varied, 45 the resulting multiplicity of rolls would greatly increase the cost of production. Fig. 11 shows diagrammatically, in an exaggerated degree, the method followed in the prior art for increasing the sectional area 50 and weight of the I-beams of a series from the minimum to the maximum sizes, the full lines indicating the minimum section, and the full and broken lines indicating the maximum section. It will be observed that 55 the depth D is the same for all sections, as is likewise the length of the flange leg F, or the minimum distance between the web surface and the extreme edge of the adjacent flange tip.

60 In the series of 15" standard I-beams shown in Figures 6 to 10 inclusive it will be observed that the dimensions L, F, and the angle α are constant throughout, and respectively equal to 13.33", 2.545" and 9° 28'.

65 Likewise referring to Figures 1 to 5 in-

clusive, it will be observed that in the new series of I-beams which I have invented, the dimension L and the angle are kept constant throughout, and in the particular I-beams illustrated are respectively equal to 70 13.33" and 9° 28'. It will also be observed that the dimension F is the same for all beams of the series and equal to 2.545", but the invention is not limited to having this dimension constant in all beams of a series. 75 The principal structural difference between my improved series of I-beams, and the I-beams of the prior art, resides in the progressive increase in depth from the lightest to the heaviest I-beams by relatively small 80 increments. Referring to the drawings it will be observed that, the depth of the I-beam in Fig. 1 is 15", the depth of beam in Fig. 2 is 15 $\frac{1}{8}$ ", the depth of beam in Fig. 3 is 15 $\frac{1}{4}$ ", the depth of beam in Fig. 4 is 15 $\frac{3}{8}$ " and depth of beam in Fig. 5 is 15 $\frac{1}{2}$ ". 85 In the practice commonly followed in the rolling of I-beams a tolerance of $\frac{1}{8}$ " under, and $\frac{3}{8}$ " over, nominal depth is allowed, and in some cases it is not unusual to increase this tolerance to $\frac{1}{4}$ " under, and $\frac{1}{2}$ " 90 over, nominal depth. It will be observed therefore that the difference in depth between the I-beam shown in Figure 1 and the I-beam shown in Figure 4 does not exceed 95 the tolerance allowed by common practice, and the difference in depth between the I-beam shown in Fig. 1 and the I-beam shown in Fig. 5 does not exceed the maximum tolerance permissible. As will be shown hereafter, by thus limiting the difference in 100 depth between the minimum and the maximum weight of beam in my improved series to substantially the tolerance allowed by common practice, and maintaining the dimension L constant, I secure, as compared 105 with the heavier beams of a series of the prior art, a considerable increase in load carrying capacity for a given weight of beam, or for the same load carrying capacity a considerable saving in weight. This follows from the fact that in my series the thickness of the flanges is varied, thus permitting the metal of the heavier beams to be disposed in its most efficient location. 115

The section modulus of an I-beam is the quotient resulting from dividing the moment of inertia of the section with respect to an axis perpendicular to the neutral fibre by one-half the depth of the beam, and the maximum safe bending moment an I-beam may withstand is proportional to its section modulus. The relative strengths of two beams therefore, is directly proportional to 120 their section moduli, and a measure of the load carrying capacity per unit of weight is therefore given by the quotient obtained by dividing the section modulus by the weight of the I-beam per unit of length.

The section moduli of the sections indicated 130

in Figs. 6 to 10 inclusive may be computed from the dimensions given, and are respectively as follows:

58.9 60.8 64.5 68.1 71.8

the corresponding weights of these I-beams per foot of length are,—

42.4 45 50 55 60

and the relative load carrying capacities per pound per foot of these I-beams are given by the quantities:

1.39 1.35 1.29 1.24 1.18

In the improved series of I-beams which I have invented having the dimensions indicated in Figs. 1 to 5 inclusive, the section moduli are as follows:

58.9 62 65.2 68.3 71.5

and the corresponding weights per foot of length are,

42.4 44.6 47 49.2 51.4

and their relative load carrying capacities per pound per foot are given by the quantities,

1.39 1.39 1.39 1.39 1.39

Comparing the lightest and the heaviest beam of the series of the I-beams of the prior art having the dimensions indicated in Figs. 6 and 10 respectively, it will be observed that the increase in weight of the heaviest over the lightest beam is approximately 43%, while the corresponding increase in section modulus is only 22%. On the other hand, in my improved series of I-beams to obtain an increase of 22% in section modulus I find it necessary to increase the weight of the section by only 22%.

Beams of the type shown in Figs. 1 to 5 inclusive may be produced in the following manner. A beam having dimensions the same as or slightly in excess of the dimensions of the heaviest beam of the series may be produced on an ordinary standard rolling mill. This beam may be used either as the heaviest beam of the series, or it may be used as a blank to form the remaining beams of the series. In the latter case the beam blank would be fed into a universal mill and the web and flanges proportionately reduced to the extent indicated in the figures.

It will be observed from the particular embodiment of my invention, illustrated in Figs. 1 to 5 inclusive, that the ratio of web thickness to flange thickness is substantially the same for all beams of the series, but I do not wish to limit myself to a series of beams having this constant ratio. Obviously in the design of the heavier beams of the series the increase in flange thickness may be proportionately greater than the increase in web thickness, thereby giving a relatively

greater load carrying capacity per unit of weight of beam. Likewise, in the design of the heavier beams of the series the increase in web thickness may be proportionately slightly greater than the increase in flange thickness, and the resulting series of beams may still have a substantially constant load carrying capacity per unit of weight.

Although the dimensions of a series of 15 inch I-beams have been illustrated in the drawings, and the invention has been described in connection with such a series, it is to be distinctly understood that the invention is not thus limited but applies to other series of beams.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. A series of I-beams of different weights, the depths of individual I-beams increasing progressively from the lightest to the heaviest, the total difference in the depth between the lightest and heaviest beams being relatively small, each beam having substantially the same load carrying capacity per unit of weight per unit of length, and the increment in load carrying capacity between two successive beams being a substantial amount.

2. A series of I-beams of different weights, the depths of individual I-beams increasing progressively from the lightest to the heaviest, the total difference in depth between the lightest and heaviest beams being not substantially greater than the usual rolling tolerances; the heavier beams of the series having a load carrying capacity per unit of weight per unit of length not less than the lighter beams of the series, and the increment in load carrying capacity between two successive beams being a substantial amount.

3. As an article of manufacture, an I-beam having the same nominal height as the lightest of a series of standard beams but being heavier, the length of the flange legs, the shortest distance between the inner flange faces measured along the web surface, the slope of the inner flange faces, being substantially the same for both beams, the sectional modulus of the heavier beam being greater, and the ratio of the mean thickness of the flanges to the thickness of the web being substantially the same for the two beams.

4. As an article of manufacture, an I-beam having the same nominal height as the lightest of a series of standard I-beams, but being heavier, the length of the flange legs, the shortest distance between inner flange faces measured along the web surface, the slope of the inner flange faces and the ratio of the mean flange thickness to the web thickness being substantially the same for both beams, and the sectional

modulus of said new beam per unit of weight per unit of length being not less than for said lightest beam.

5. As an article of manufacture, an I-beam having the same nominal height as the lightest beam of a series of standard beams, but being heavier, the ratio of the mean flange thickness to the web thickness being substantially 1.5 for both beams. 25
6. As an article of manufacture, an I-beam having the same nominal height as the lightest of a series of standard I-beams, but being heavier, the slope of the inner flange faces and the ratio of the mean flange thickness to the web thickness being substantially the same for both beams, and the sectional modulus of said new beam per unit of weight per unit of length being not less than for said lightest beam. 30
7. As an article of manufacture, an I-beam having the same nominal height as the lightest of a series of standard I-beams, but being heavier, the length of the flange legs and the ratio of the mean flange thickness to the web thickness being substantially the same for both beams, and the sectional modulus of said new beam per unit of weight per unit of length being not less than for said lightest beam. 35
8. As an article of manufacture an I-beam having the same nominal height as the lightest of a series of standard I-beams, but being heavier, the shortest distance between the inner flange faces measured along the web surface and the ratio of the mean flange thickness to the web thickness being substantially the same for both beams and the sectional modulus of said new beam per unit of weight per unit of length being not less than for said lightest beam. 40
- In testimony whereof I hereunto affix my signature.

GEORGE H. BLAKELEY.