ON GIRDERS AND FLOOR BEAMS.---THE EFFECT OF CROSS-BRIDGING.

MASON CITY, IOWA. June 5, 1873.

MESSRS. MUNN & Co., New York city:

Gentlemen:—A building having joists 28 feet long, 2 inches x 12 inches, has a stringer 20 feet long, 6 inches x 8 inches, running crosswise and under the joists, supported at each end vertically. How much greater weight, if any, would it support at the center—weight being made to bear on two joists only—by having the stringer securely fastened to each joist, without weakening the joists or stringer? The joists are common pine; the stringer is of yellow pine. The joists are 16 inches apart.

There is a great difference of opinion; please give yours as fully as will explain the above. Very respectfully,

A. S. CHINES.

REMARKS BY THE EDITOR.—In the examination of this question, it is evident that if the "joists" or floor beams are so disconnected that when the load is applied it deflects only the two beams upon which the load rests, then attaching the "stringer" or girder to the other beams will increase the strength, and consequently the load upon the floor may be safely increased.

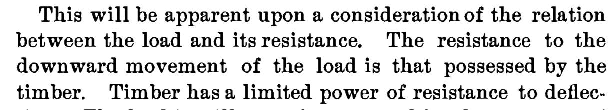
This will be apparent upon a consideration of the relation between the load and its resistance. The resistance to the downward movement of the load is that possessed by the timber. Timber has a limited power of resistance to deflection. The load it will carry is measured by the measure of this resistance.

Now the girder has a certain amount of resistance, and each of the floor beams has its resistance; and it is evident that, as the whole is greater than a part, so the girder assisted by all the beams will be stronger than if assisted by only two of them. The floor, therefore, will carry an increased load in consequence of attaching all the floor beams to the girder.

As to the amount of the increase in the load, that will now be considered.

Experiment has shown that within the limits of elasticity the deflection of a beam is directly in proportion to the weight laid upon it. For example: If 100 pounds deflect a beam one inch, 200 pounds will deflect it two inches, and so in like proportion for all weights and deflections.

Now, of the several beams attached to the girder, the service that each will render, in resisting the weight, will be in proportion to the distance it is deflected. The beams will all be deflected just as much as the girder is, but the amount of deflection which each will sustain will be according to its position upon the girder, the greatest deflection being at the middle of the girder, and thence each way to the ends, the deflection gradually diminishing to nothing at the ends. In deflecting the girder the upper surface becomes curved, and an ordinate to this curve, drawn at each beam, measures the deflection of that beam. But to avoid the intricacy involved in obtaining these ordinates, it will be sufficient for the present purpose to consider the top of the girder as not curved but declining from each end in straight lines to the point of greatest depression at the middle. Thus in Fig. 1, if ADB be the top line of the girder when deflected by the load at the mid-

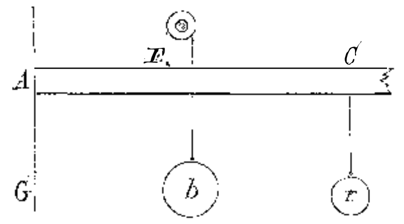


dle, then CD will be the deflection at the middle, and EF the deflection at E. AEF and ACD are similar triangles, therefore their corresponding lines are in proportion, thus, AC : CD :: AE : EF; or, putting for these several lines respectively the letters l, a, m, and b, then $l : a :: m : b$, from which $b = a\frac{m}{l}$. This expression gives the value of the line EF, drawn at any distance from A, and hence may be used to obtain the deflection of each beam located anywhere from A to C.

This gives the deflections, but inasmuch, as before stated, the weights are as the deflections, therefore a and b are in proportion as the weights which deflect the two beams at E and C; or when, by any scale, CD measures the weight which is required to produce the deflection, CD, in a beam crossing the girder at C, then will EF by the same scale, measure the weight required to produce the deflection, EF, in a similar beam crossing the girder at E; or $b = a\frac{m}{l}$, when b equals the weight at E, and a, that at C.

By this formula, the resistance which each beam exerts may be ascertained. But this resistance is that which is exerted by each beam at its location; while the weight to be resisted is not at the beam, but at the middle of the girder. The resisting power, therefore, will have to act with leverage, and this leverage will now be considered:

Let AC, Fig. 2, represent one half of the girder, and AG the face of the wall supporting one end of the girder:



Let a weight, b, equal to the resistance exerted by a beam located at E, be suspended by a rope over a pulley, the other end of the rope being attached to the girder at E. The weight, b, may thus represent the resistance exerted by the beam located at E; and when there is an equilibrium between this weight and the weight, r, suspended from the middle of the girder, then r will represent the weight at the middle of the girder which will be sustained by the resistance of the beam at E. To obtain the value of r, it may be observed that the weight, b, acts with the leverage, AE. Let m represent this distance. The weight, r, acts with the leverage, AC, or half the girder, equal to l. Now, when there is an equilibrium, the product of one weight into its leverage equals the product of the other weight into its leverage, hence $bm = rl$, from which, $r = b\frac{m}{l}$.

Substituting, in this expression, for b, its value $a\frac{m}{l}$, as before found, then $r = a\frac{m}{l}\cdot\frac{m}{l} = a\frac{m^2}{l^2}$.

In this expression, r equals the weight, at the middle of the girder, which will be resisted by any one of the beams crossing the girder at the distance m from A; and a represents the weight which will be resisted by a beam located at the center of the girder. From this expression the resistance of each beam may be had. In order to gather the several resistances in one, let the beams as they cross the girder divide it into equal spaces, and let c equal one of these spaces. Now the distance AE, Fig. 2, from the end of the girder to the location of one of the beams will contain a certain number of these spaces. Let n equal this number; then cn will equal m, the distance AE, and may be substituted for it, thus: $r = a\frac{m^2}{l^2} = a\frac{c^2n^2}{l^2} = n^2\frac{ac^2}{l^2}$.

In this expression, a, c^2 and l^2 are constants; that is, for any given case, they will not change, in the application of the formula to each beam. For convenience, let $t = \frac{ac^2}{l^2}$; then $rn = {}^2t$.

For the first beam from the end, $n=1$, for the second beam, $n=2$, for the third, 3, and so on to the middle of the girder.

Now, in this case, there are 14 beams crossing the girder. 7 on each end, or 6 besides the 2 nearest the middle which carry the load.

The several values of n, for these six beams, are 1, 2, 3, 4, 5, 6; and the several values of n^2 are 1, 4, 9, 16, 25, 36.

The sum of the resistances, therefore, of the six beams, is

$$R = 1t + 4t + 9t + 16t + 25t + 36t.$$
$$R = t(1 + 4 + 9 + 16 + 25 + 36).$$
$$R = 91t.$$

The sum of the resistances of the other six beams being the same, therefore, for the twelve beams, $W = 182t$, or, substituting for t its value: $W = 182\frac{ac^2}{l^2}$.

The value of c for this case is 16 inches, $= 1\frac{1}{3}$ feet, and $c^2 = 1\frac{7}{9}$. The value of l is 10, and of l^2, 100.

The value of a is to be obtained from* $a = \frac{Enbd^3}{l^2}$, in which b, d, and l respectively stand for the breadth, depth and length of the beam; E is a constant, derived from experiment, and for white pine equals 1750; and n is the rate of deflection per foot of the length of the beam.

If the rate of deflection in the girder, which is 20 feet long, be assumed at 0·04 of an inch per foot, then the rate of deflection of a beam at the middle of the girder will be 0·0286, the beam being 28 feet long; therefore $n = 0{\cdot}0286$. The beam being 2×12, $b=2$, and $d=12$; also $l=28$. Therefore $a = \frac{Enbd^3}{l^2} = \frac{1750 \times 0{\cdot}0286 \times 2 \times 12^3}{28^2} = 220{\cdot}63$.

Therefore $W = 182\frac{ac^2}{l^2} = 182 \times \frac{220{\cdot}63 \times 1\frac{7}{9}}{100} = 713{\cdot}86$.

This is the additional load at the center due to the assistance afforded by the 12 beams.

The resistance of the girder and that of the two beams may now be ascertained. For one of the two beams, the same formula will serve as for each of the others, thus, $r = a\frac{n^2c^2}{l^2}$. In this case $n=7$ and $n^2 = 49$, therefore $r = 220{\cdot}63\frac{49 \times 1\frac{7}{9}}{100} = 192{\cdot}19$. And $2 \times 192{\cdot}19 = 384{\cdot}38$ = the resistance afforded by the two beams. The formula $W = \frac{Enbd^3}{l^2}$ will give the resistance of the girder. The girder is of yellow or Georgia pine; for this wood, $E = 2970$. The value of n is, as before assumed, 0·04, and $b=6$, $d=8$, and $l=20$. Therefore $W = \frac{2970 \times 0{\cdot}04 \times 6 \times 8^3}{20^2} = 912{\cdot}38$.

The several results are as follow:

The resistance of the girder	912·38
The resistance of the two beams	384·38
Girder and two beams	1296·76
The resistance of the 12 beams	713·86
Total resistance is	2010·62

Or, in round numbers, the girder and two beams will sustain safely 1,300 pounds; but if aided by the other beams, as proposed, they will sustain 2,000 pounds. The addition is about 65 per cent. Stronger beams would make the percentage of increase higher.

The question discussed in this article is essentially that of the value, in a tier of beams, of what is known as "cross bridging;" for when beams are braced to each other by this device, they each help to sustain any concentrated weight.

SCREWS IN PLASTER WALLS.—W. A. A. of Hartford, Conn., states that screws are best inserted in plaster by making the hole large enough and driving in a wooden plug. It is better to split the plug and cut a groove in each half.

* *American House Carpenter*, page 206. (38.)

The Patent Law Discussion.

A correspondent, E. A. B., of Georgia, writes as follows, in regard to the first question propounded by the Secretary of State (see page 7 of our current volume): "Is the protection of inventions by patents just and expedient, and, if so, on what grounds?"

"There are two theories on the subject, of which yours is one. I will say a few words about each in turn. 1. One is expediency, held by you. If, as you say, patents are a 'tyranny,' no expediency could make them other than a wrong. If we use the word expediency to signify the advancement of men, moral, then mental, then material, it never could be gained by violation of men's rights. Men have not 'equal rights;' they have merely an equal claim to justice or to defense of their rights. On the ground of expediency, men cannot be made to feel an obligation to sustain patent or other laws. It is sometimes said that, when regulations of expediency become the law of the land, it is thereby made a duty to obey them. But this goes on the supposition that the claim of a government does not depend on the justice of its laws, but the justice of its laws depends on its will. This makes all forcible revolutions, without exception, wrong; and its operation would have for ever prevented free government. Expediency does, however, help to determine all questions of human property.

2. The other theory puts patents, along with other property, on the ground of men's convictions of right. Men do, in a thousand ways, show that they have the conviction that what any person produces by his sole work is rightfully his property. But this principle alone will not serve as a basis for men's property, either in ideas or things material. Ideas are mere abstractions, and property does not consist in abstractions. Property is exclusive, and different men might have the same ideas. As to the material property of men, it cannot rest on the mere conviction that every person rightfully owns what he produces by his sole work. Since men cannot create, in the proper sense, it is clear they cannot by their sole work produce anything. They must have material and instruments, and a right to them. Thus neither theory alone is sufficient foundation for any right of property. But put the two together and they are worth something. The ownership is in the Creator of the world, and of course He could convey it to men. That laws recognizing and protecting ownership in men do advance men's interest, moral, mental, and material, in the order named, is a proof or sign that God designs to convey ownership. For, on any view of God, held by civilized people, He designs the progress, first moral, then mental, then material, of all who aim thus to advance; and this is best furthered by laws recognizing and protecting property. God designs that manufacturers should pay wages to the inventors for the mental labor of the latter, as well as to operatives for their manual labor, as He designs that the public shall pay the manufacturers for their goods. We know that God wills it because the legitimate interests of human beings are advanced by it, or, in other words, it is expedient in every sense.

Whenever we cannot get any work voluntarily done which the permanent interest of the public demands, without recognizing some right of property, it is a sign that right exists. It is very desirable to keep the popular discussion of this matter from getting on metaphysical grounds. If those who see that it is impossible to settle any question of property without using the argument from expediency would guard their language and call expediency merely a sign or token of existing right, not the origin of right, they would keep off metaphysical ground. It would also conduce to the same end if men would not talk of 'right of property in ideas,' but of the right of inventors and authors to wages.

The first subject of inquiry consists really of two vastly differing questions. That patent laws are expedient, I have assumed because I was discussing the right, and it was necessary to show its relation to expediency. But the existence of expediency is one of the points of inquiry."

New Method for Boot and Shoe Heels.

John Blakey, of Leeds, England, has lately patented in this country a method or process of forming heels or heel lifts for boots and shoes, by first cutting, from waste scraps of leather, small pieces of appropriate size and shape; next, compacting and solidifying such pieces into a solid bar, with or without a wooden core, by means of adhesive material and pressure; next, drying the same, and then cutting or sawing the same into heel lifts of the desired thickness.

A New Motor.

Louis Charles Errani and Richard Anders, of Liége, Belgium, have patented in this country a new motor, operating as follows: Oil is sprayed into the cylinder behind the piston, and, being mixed with air, is ignited at the proper point by an electric device; the consequent expansion drives the piston forward, the momentum of the fly wheel returning it to its first position. An ejector supplies the oil from the tank to the sprayer, the ejector being connected to a piston blower driven by a crank attached to the main shaft. The general principle is the same as the gas engine.

IT appears from the researches of Dr. D. J. Macgowan, of Shanghai, that the medical virtues of fish oil as a cure for lung complaints was known to the Chinese many centuries ago. But instead of codfish, they take the oil from the shad. Acting on this hint, our apothecaries may perhaps be saved the necessity of sending to Newfoundland for their supplies, as the waters of the Hudson, Connecticut, Chesapeake, and other rivers will afford an abundance of the medicine.

J. M., of Cal., "hopes that the circulation of the SCIENTIFIC AMERICAN will increase till it is read by every mechanic in the land."