FRIDAY, APRIL 23, 1897.

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Contributions.

A Chance for the Locomotive Builders.

TO THE EDITOR OF THE RAILROAD GAZETTE:

I have lately had occasion to make a pretty extensive and careful study of motive power for suburban and interurban service, and the impression left on my mind is that the locomotive builders have not taken hold of this proposition as aggressively as their interests would seem to require. The electric fever seems to be running its course without opposition. It is now threatening to enter a field which will undoubtedly cut down the demand for locomotives engines, especially passenger engines, and, in view of the rather uncertain conditions attending the use of electricity, especially for long-distance transmission, locomotive builders, by turning their attention to the construction of a swift and comparatively noiseless motor, will offer the steam railroads a very acceptable solution of the difficulties which now confront them in meeting this character of competition. In conversation with the officers of one or two other roads, I find they are anxiously waiting for some development of this character.

A RAILROAD PRESIDENT.

DuBois' "Framed Structures."

NEW HAVEN, April 14.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In your issue for April 2 a review of my "Framed Structures" appears, to some points of which I feel compelled to take exception.

First as to my use of the signs for bending moment "in a contrary sense to that of general custom."

It is the universal convention in mathematics to take angles positive when measured counter clock-wise. For the same reason, rotation and "moments" in analytical mechanics are positive when counter clock-wise. These conventions are universal, and it would seem proper to keep to them in all applications of mechanics. They are adhered to in fact in every application I know of, except in just this one subject.

After a student has acquired these conventions, it can only be regretted that "general custom" in this one subject only, should call upon him to reverse them. I have, therefore, conformed to them. Accordingly I make a right-end positive reaction cause a positive moment about any point on the left and compression in the upper chord. A left-end positive reaction causes a negative moment about any point on the right, and also gives compression in the upper chord. This is simple and in accord with the universal conventions of mathematics and analytical mechanics. If in this one subject it seems to anybody "unnatural to take the moment of the left reaction as negative," I can only say it seems to me a pity that such a state of mind should any longer continue or be encouraged. The conventions I have used are universal. It is confusing to shift them back and forth.

As to definition of the word "fixed," I have illustrated very thoroughly the meaning of fixed end, and can only say that in a teaching experience of 20 years I have never found a student who regarded it as a "mystery."

In the case of the roof truss referred to, in which, by the way, I have sought to illustrate "how not to do it," it is evident that if the figure were turned upside down, so that we have a load supported by three strings, the method and results would be beyond criticism. As it stands, the results are perfectly correct if we suppose the lower chord not to bend or sag. As I wished at the same time to illustrate the method of least work and also its application to redundant members, and as the remarks which follow in the text seem so entirely in accord with the review, it would seem that extended criticism of such a passing illustration was somewhat unnecessary if not misleading.

As to the swing bridge, I would say that if my conclusions were really based upon a single calculation of a "truss of 160 ft. length with only four panels in each span and a depth of only 10 ft. at the pier," they would indeed be unworthy of confidence. Such a truss is certainly not a "fair practical case." I am in fact somewhat amazed that such an idea could have been gathered from my text. I have never tried to base any general conclusions upon special cases, much less upon unfair special cases. I have not done so in this instance. My conclusions are drawn directly from the general formulas themselves. These all reduce to the common formulas upon the concurrent assumptions of constant area of cross-section, constant depth and small panel length. The common formulas are indeed deduced upon just these assumptions, and hence come out as special cases of my general formulas, as they should, thereby confirming the accuracy of the general formulas themselves.

I simply illustrate the application of my general formulas by means of the truss referred to, which is taken in order to avoid tedious numerical computations. Incidentally I point out the difference due to the use of the common formulas in this special case. But my conclusions precede the example. They are not drawn from it, but simply illustrated by it.

This is the first application of least work to the subject that I know of, and I regard it as beyond question correct. It would be the work of less than 10 minutes for any one "following copy" to enlarge the formulas so as to include the bracing also. This I have done. But I found that the added terms disappear when the chords meet in a point at the ends, and can be neglected for practical cases of inclined upper chords. I have therefore omitted them. That there is thus a balance of errors in the common formulas, enabling them to apply without too much error to cases for which they were not really deduced, can only be regarded as a happy chance. It is luck, not "science."

As to the suspension system, here also is the first application of least work to the problem. I consider my treatment perfectly correct and the fullest which the subject has yet received. The way is, however, opened up, and any one who takes the standpoint of your reviewer can here also "follow copy" and obtain the corresponding results. Such a method of presentation would seem worthy of notice.

If your reviewer had taken the trouble, as I have done, to thus test his idea, he would have found the fraction of the live load carried by the cable to come out equal to unity. In other words, when the cable is carrying all the dead load, if a live load is placed on the girder, the cable will carry all of that also. Such a result is evidently incorrect and the idea which leads to it must be erroneous.

In view of the preceding, I cannot help feeling that my work in this field is not properly estimated by the review in question.

A. J. DUBOIS.

[All books on stresses, except that of Professor Du Bois and a few German and French ones, regard rotation as positive when the direction is the same as that of the hands of a watch. We are surprised to learn that the opposite convention is "universal" in analytical mechanics; for our recollection of the works of Peck, Bartlett and Rankine is otherwise. On referring to Rankine's Applied Mechanics we find that he defines right-handed couples and right-handed rotation as positive, and surely no one can deny that this work is an authority on analytical mechanics.

With regard to the word "fixed" our criticism related only to the equations used in finding the reactions of fixed beams by the method of least work. These equations contain nothing, implying that the beam is horizontally restrained at the end. For instance, the equation for the work of a beam given on page 308 applies to a simple beam supported at both ends just as much as to a beam fixed at one end and supported at the other. There is nothing in this algebraic reasoning which justifies the conclusion that the value found for the reaction belongs to the latter case.

With respect to the swing bridge it is not clear how the conclusion was arrived at if not by the comparison of particular cases. Winkler, Turneaure and others have made numerical comparisons showing beyond all doubt that the common formulas do apply to most practical cases. This is certainly not the first discussion of swing bridges by the principal of least work, for one by Merriman will be found in our issue of Sept. 6, 1895. Further comment seems unnecessary regarding the triangular truss.

The first discussion of the suspension truss by the method of least work appears to have been published by Martin in a paper in *Engineering* in 1889. We have re-examined the investigations of Professor Du-Bois, and find it, in our judgment, to involve the most serious errors in the book. If the algebraic work be carried through, after making the proper corrections in equation (26), it will be seen that the unknown fraction cannot be found, it being mathematically indeterminate. Such must indeed be the case, for the principle of least work cannot be applied to finding the stresses for a design whose sections are unknown. As a word of warning to those who imagine otherwise, a remark by Morison in his recent elaborate paper on suspension bridges is here most appropriate: "It is not possible to make a strain sheet in advance and then proportion the sections in accordance with the strains. Everything is determined by deflections, and deflections are themselves determined by sections."

The concluding paragraph of our review shows the high estimate we place on the labors of Professor Du-Bois. Our criticisms on his misapplications of the principle of least work were made in the interests of sound science and correct engineering practice.—EDITOR RAILROAD GAZETTE.]

Sixteenth Street Crossing, Chicago.

Many have thought that the railroads interested would surely agree to the latest plan proposed for doing away with the grade crossing at Sixteenth street, in Chicago, and have expected that definite action would at last be taken. These were surprised when the Chicago & Western Indiana at the last moment refused to accept the new ordinance on the ground that the Chicago & Erie would lose yard room. This ordinance was drafted in accordance with plans prepared by the railroad engineers, and was passed by the Chicago City Council on March 9, with the understanding that the railroads had already agreed to it among themselves. The roads were given by the ordinance twenty days in which to file their acceptances. An important provision of the ordinance granted the South Side Elevated (the "Alley L") the right to erect and maintain an elevated structure in Harrison street to form a connection with the Union Loop, and the wording of the ordinance was such that in case the other railroads failed to accept, thus rendering it inoperative, the South Side Elevated could still retain its right to use Harrison street. In return it was required to raise its tracks to clear those of the St. Charles Air Line when brought up to its proposed grade.

A plan of this very complicated railroad crossing was published in the *Railroad Gazette*, April 24, 1891, which plan is sufficiently correct to show the general arrangement of the tracks at the present time. By the ordinance passed March 9, the tracks of the St. Charles Air Line were to be elevated to a point 22.25 ft. above city datum at Clark street, and were also to be shifted, making the new crossing 75 ft. south of its present location; this road was also to cross State street, Wabash avenue and Indiana avenue, lying east, at an elevation sufficient to permit of the building of suitable subways at these points. West of Clark street the Air Line was to descend, reaching and crossing the tracks of the Pittsburgh, Fort Wayne & Chicago R. R. at the present grade.

The Chicago, Rock Island & Pacific and the Lake Shore & Michigan Southern were required by the ordinance to raise their tracks beginning at a point north of Fourteenth street and reaching an elevation of 21.50 ft. above city datum at Clark street, thus crossing the St. Charles Air Line on the new grade; in the same manner the Chicago & Alton tracks were to be elevated so as to cross the St. Charles Air Line on the present grade.

The track of the Chicago & Western Indiana and the Atchison, Topeka & Santa Fe were to be depressed at Clark and Sixteenth streets to a point 4 ft. above city datum, passing under those of the St. Charles Air Line, the Chicago, Rock Island & Pacific, the Lake Shore & Michigan Southern and the Chicago & Alton. Clark street with the electric street railroad was to be carried over the Chicago & Western Indiana and the Atchison Topeka & Santa Fe by means of a viaduct.

There are so many railroads interested in any changes made at the Sixteenth street crossing that it has been a difficult matter to perfect a plan which would not put one or more of them at a disadvantage, and it was therefore no more than to be expected that the earlier efforts to bring those interested together failed because some roads were favored at the expense of others. The latest plan, as outlined above, divides the work very equally among all and while there would remain a few railroads crossing the St. Charles Air Line at grade, it would be a simple matter to protect these crossings by a system of interlocking signals, while the chief source of delay and danger, the crossing of Clark street at grade, would be entirely removed. The plan which has unfortunately been rejected presents a fair, practical solution of a most dangerous and complicated railroad problem. The fact that all the roads excepting the Chicago & Western Indiana formally agreed and accepted the ordinance throws the responsibility of delaying an important and needed improvement upon that road and it is not apparent what the road expects to gain by blocking a measure of so grave importance. It is held that the city of Chicago has the right to force the railroads to elevate their tracks at street crossings, but up to the present time the city and railroad officials have been able to agree on track elevation matters and little trouble or friction has occurred. It is now a matter of conjecture what will be the policy of the newly elected city officials and the new council, on matters pertaining to track elevation; therefore immediate action is hardly to be expected, but it is a problem which must eventually be settled and quite probably along the lines laid down in the ordinance passed on March 9.