We denote the statically indeterminate values:

Suppose that the horizontal thrust on the support to be denoted by $X_1$ and on the spring of the transom by $X_2$, using the well-known formulas:

$$(1) \qquad \int \frac{M}{E\,I} \frac{\delta M}{\delta X_1} ds + \int \frac{N}{E\,F} \frac{\delta N}{\delta X_1} ds = O.$$

$$(2) \qquad \int \frac{M}{E\,I} \frac{\delta M}{\delta X_2} ds + \int \frac{N}{E\,F} \frac{\delta N}{\delta X_2} ds = - \frac{X_2\,l}{E_o\,F_o}.$$

the two methods, unless we consider that the frame with a tie is 4 feet higher and has the same cross-section as the frame without a cross-tie. For the construction of the latter frame it cannot be considered that saving of material is of the first importance, but rather that reduction of cost for labor for the frame without a cross-tie inasmuch as the correct workmanship for the tension plate (which, furthermore, would have to be suspended from the vertex of the transom) would increase the cost of the structure, and for the handling of the storage owing to the greater height. All these facts are of more importance

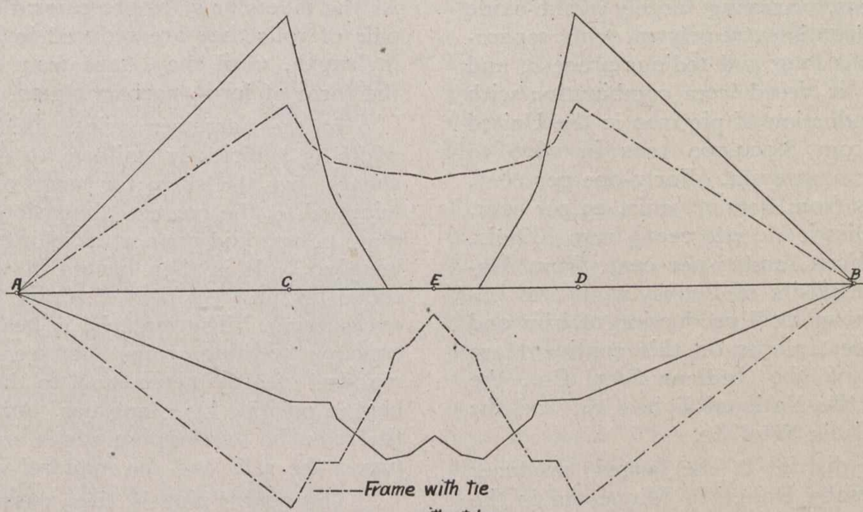

**Fig. 3.**

Notwithstanding the fact that the tie is embedded in concrete to protect it from the corroding effects of smoke, etc., and forms a part of the monolithic structure of the frame, the flexibility of the tie is not affected. This assumption has been found to be true on several similar constructions which the writer has designed and constructed.

Inserting in the equations the values of $M$, $N$, $\frac{\delta M}{\delta X_1}$, $\frac{\delta M}{\delta X_2}$, $\frac{\delta N}{\delta X_1}$ and $\frac{\delta N}{\delta X_2}$, for the individual members of the structure, we obtain:

$$(1) \qquad \int_o^h \frac{M_o - X_1 y}{E\,I_o} y.dy + \int_o^h \frac{M_o - X_1 y}{E\,I_o} y.dy + \int_o^s \frac{M_o - X_1\,(h+y) - X_2\,y}{E\,F_1} (h+y)\,ds - \int_o^s \frac{(X_1 + X_2)\cos\alpha}{E\,F_1} \cos\alpha\,ds = O.$$

$$(2) \qquad \int_o^h \frac{M_o - X_1\,(h+y) - X_2\,y.}{E\,I_1} yds - \int_o^s \frac{(X_1 + X_2)\cos\alpha}{E\,F_1} \cos\alpha\,ds - \frac{X_2\,l}{E_o F_o} = O.$$

From these equations we may determine the two unknown values and find the moments shown in Fig. 2 again for all four methods of loading.

Comparing the curves for the maximum bending moments of both methods of calculation, there is at first no substantial advantage to be noticed adhering to either of

when we consider that such plants may be erected in quite a number of stations.

The above example is one of many tending to show conclusively that some structures in reinforced concrete may be designed on economical principles only with a thorough knowledge of statics.

## COPPER AND SILVER MINING IN 1913 IN MICHIGAN.

Returns received by the survey in connection with mine production of copper and silver in Michigan in 1913 shows that the production of copper from ore mined in Michigan during 1913 was 135,853,409 lbs., having a value of $21,-057,278, the copper being calculated at an average value of 15.5 cents a pound. The mine output was much smaller than the smelter production, as considerable material mined and milled previous to 1913 was smelted during the year. The production compares with an output of 218,138,408 lbs. in 1912, valued at $35,992,837. Due to the labor troubles which began July 23 and continued for the rest of the year, the output of all mines was greatly reduced in the latter half of the year, and several mines were not operated after July 23. The mines produced 7,016,307 tons of ore with an average copper recovery of 19.36 lbs. to the ton, compared with 11,411,941 tons of ore in 1912 with an average copper recovery of 19.1 lbs. to the ton. In addition to copper, the mines produced 295,173 ozs. of silver in 1913, compared with 528,-453 ozs. in 1912.

Writing upon the matter of crystallization through fatigue of iron and steel in *Iron and Steel Inst.*, September, 1913, Mr. F. Rogers states that the crystalline structure frequently shown by wrought iron or steel which has given way through repeated stress does not appear to be the result of fatigue, since in every case of such failure coming under the author's notice, a fracture of similar appearance could be obtained in an unfatigued part of the metal. Examples of the failure of wrought iron are given in which such crystalline structures, in both the new and the fatigued metal, were due to the presence of low-grade iron or steel scrap.