VERTICAL VERSUS INCLINED SAWTOOTH SASH.

The title of this article evidently smacks of a controversy. It has, however, only the intention of setting forth the advantages and disadvantages of both the vertical and inclined sawtooth sash. There has been much discussion among designers of industrial plants of the relative merits and demerits of both of these types, and it must be remembered that each individual case in which sawtooth construction is required should be analysed and the proper style selected best fitted to fill the requirements.

As the principle of the so-called sawtooth form of skylight is a diffusion of a strong northern light into the workroom without admitting any direct sunlight, either the vertical or inclined sash will be effective to accomplish the end in view, provided only that there is a sufficient area of glass. Regarding the effective lighting area, it has not been clearly demonstrated that with equal glass area the vertical sash will not provide as good lighting facilities as a sash inclined only to such an extent that no direct sunlight will be admitted.

About the maximum angle of inclination allowable in the United States without the entrance of any direct sunlight is about 15 degrees, being less in the South and greater in the North. Granting that there may be a slightly greater lighting effect using the inclined sash, let us endeavor to

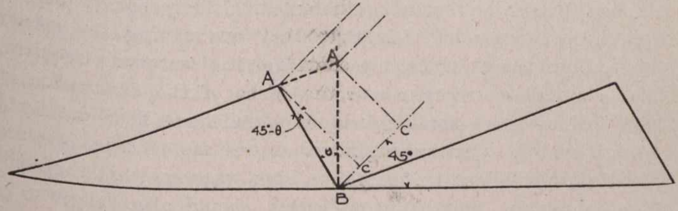

Fig. 1.

determine to what extent the glass area should be increased in order to have the same lighting effect with vertical sash. Taking the direct northern sky light at 45°, let it be considered that the "effective lighting area" of a sash is its length times its normal projection on these rays. Referring to Fig. 1, the effective lighting area of sash AB, inclined with the vertical at an angle θ, would be AC = AB cos $(45^\circ - \theta)$.

On the above hypothesis, should the sash be vertical, that is, $\theta = 0$, the projection on the normal of the north light rays, A'C' should equal AC in order to have equal intensities of light. But

$$A'C' = A'B \cos 45^\circ, \text{ and as}$$
$$A'B \cos 45^\circ = AB \cos (45^\circ - \theta),$$
$$AC = A'C',$$
$$\text{or } A'B = AB \frac{\cos 45^\circ - \theta}{\cos 45^\circ}.$$

Where $\theta = 15^\circ$ this ratio is as 1:1.23; that is, vertical sash should have about 23 per cent. greater glass area than sash inclined at 15° to secure the same intensity of light. In actual practice, however, it has been found that it is not necessary to increase the glass area to this extent to receive satisfactory lighting.

Mr. F. W. Dean, of Boston, who has designed a number of mills with vertical sawtooth sash, uses the simple expedient of figuring an inclined sash the proper size and proper angle to secure the desired amount of sky light without any direct sunlight, and then projecting the roof until it meets the vertical, the increased height of the sawtooth face being entirely devoted to glass, and in every instance this method has given satisfactory results in regard to light.

It is generally admitted that as regards construction the vertical sawtooth is much easier to erect and adapts itself particularly well to steel construction, as, instead of resting the whole sawtooth on carrying girders, the vertical face can be made in the form of a light truss to take the place of the girder. Furthermore, with the vertical type, ordinary pivoted sash may be used, so that in hot weather the entire front of the sawtooth face can be opened for ventilation. The increased heating effect of the additional roof area exposed normally to the sun's rays would be more than offset by the increased ventilation thus secured. Furthermore, where condensation drip is apt to cause trouble, the vertical sash will be the better form to use.

Concerning cost, Mr. Dean has found that contractors, when requested to submit comparative bids on the two types of construction for the same job, made practically no difference in price, but on rush work the completion of a job would be promised in a shorter space of time with the vertical style than with the inclined owing to the fact that in most cases special sash for the inclined face would have to be purchased or installed by the manufacturer or by a subcontractor.

The amount of direct sky light transmitted into a mill by the vertical rays which would strike the inclined sash would be practically nil, owing to the cutical angle of glass, which would cause much of the light to be totally reflected and would allow very little to enter into the mill. Moreover, there is some question about the desirability of having narrow bands of the more intense light under each sawtooth due to the vertical rays, if they were transmitted.

MODERN HIGHWAY BRIDGE CONSTRUCTION.*

By F. J. Kersting, Deputy State Highway Engineer, of Missouri.

The question is frequently asked, why are the bridges which we build to-day less permanent than those which the ancient built. Our answer is the item of cost, chiefly because we build a vastly greater number of bridges than did the ancients. We build solely for the accommodation of the public, as we live by peaceful pursuits, whereas the ancients lived by conquest, being almost continually at strife, and built mainly for army manoeuvres.

The earliest bridges of which we have information were pile trestles; the Pons Sublicius built over the Tiber at Rome about 600 B. C., also the bridge across the Rhine built by Caesar in 55 B. C. Concurrent but in other countries, was the masonry arch which is found as an architectural feature in the ruins of Nineveh, which ceased to be a city about 600 B. C. The arch was also used by the early Egyptians, but its use was practically unknown to the Greeks at a later period. The Romans were the first to bring the arch into general use, and as civilization progressed this type of bridge was developed until in 1390 the great masonry bridge at Trezzo over the Adda was built of one span of 251 feet. This, then, is another answer: the ancients were fortunate in knowing of only two kinds of bridge construction, the pile trestle which soon rotted away, and the masonry arch, some examples of which are standing to-day after the lapse of centuries.

An Italian architect named Palladio is generally supposed to have been the first man to use the correct principle of truss construction—the rigid triangle—and this as late as 1570. Although he wrote a treatise in which his trusses are described, his example was not followed until more than 200 years later.

*Paper presented at the annual meeting of the Highway Engineers' Association of Missouri, Kansas City, Mo.