is equipped to do economically might be very expensive in another. It is only fair, then, that considerable latitude be given in such matters as long as the results are satisfactory. A good detailer requires more than a knowledge of stresses, materials and shop methods. He must be endowed with considerable inventive genius and what the artist calls "technique." In the production of neat, compact and simple details, of not the least importance is a habit of rigid economy such as can only be acquired by breathing for a time the atmosphere of a contractor's office. To attain the best results often requires the co-operation of several minds, even in such a simple structure as a highway bridge.

The issuing of these standard plans will probably establish the use of the box section for top chords for Warren trusses and abolish the "T" chord, at least for spans over 50 feet. By way of funeral oration the writer feels like saying a last good word for the old "T" chord. It is a fact that many "T" chord trusses have failed in the past and there are many more which, although they have not actually failed, are yet very unsatisfactory. On the other hand, there are literally scores of bridges in this province with "T" chords and for spans up to 100 feet which are giving perfect satisfaction. The "T" section is used so extensively in engineering for compression members and is the base of so many designs, such as roof trusses and other framing, the flanges of columns, beams and girders, that some explanation is necessary as to what has given it a bad name in highway bridges.

An investigation of the instances of weakness and failure will invariably show faulty design. In fact, the peculiar properties of the pony Warren truss are disregarded by most designers and because the box chord has a factor of safety large enough to cover these errors—errors which would wreck a "T" chord—the latter is condemned. Some interesting examples of this common oversight are illustrated in these standard designs. For instance, it is usual, in proportioning the top chord section of a truss to consider the unsupported length, in a horizontal plane, to be one panel length. On this principle the sinuous or elastic curve for the top chord of a three-panel truss is assumed to be as shown in Fig. 1. The correct assumption is, however, more like Fig. 2, in which the unsupported length is two panels. For trusses of more than three panels the unsupported length will be one and a half panels. (See Fig. 3.) It will also be noted that splices in the chords always come near the centre of the column where the bending moment is likely to be a maximum.

Referring to the standard plans (Plate No. 2) for 40, 42 and 44-foot spans, 16-foot roadway, we find that this is the only standard with a "T" chord, whereas of all others these three-panel trusses should have box chords. The l/r, instead of being 78, as stated, is really 156, and the value of the chord in compression is only 31,000 pounds, whereas the estimated stress is 58,800 pounds.

Now, it so happens that in most cases the box chord has the necessary stiffness to take care of such errors as these and the splices are better able to resist bending than the usual "T" chord splice. The end posts and diagonal members also impart more or less stiffness to the chord. Hence the preference for this type of construction. The box chord truss, however, costs from 25 to 50 per cent. more than the "T" chord truss. As for cost of maintenance and for durability, the box chord has on an average 75 per cent. more surface to rust and probably costs twice as much to paint. If a carefully designed "T" chord truss can be made perfectly safe and satisfactory, is an engineer justified in recommending the public to pay the additional cost for a box chord bridge?

As for the three-panel truss, the writer has sometimes used the old queen-post design in which the uncertainties are eliminated and the results are quite satisfactory.

DRAINAGE IN THE RED RIVER VALLEY IN MANITOBA*

By G. B. McColl, D.T.S., M.L.S.

THE basic industry of Manitoba is agriculture and the greatest economic service we can render the Empire is to increase the production of foodstuffs. The extent of arable land in this province is limited so that the opportunity for improvement lies largely in increasing the production of those areas already taken up for cultivation. Next to the soil itself, the most essential requirement for successful farming is the proper control of surface water. In thorough and systematic drainage lies the only hope of insuring good crops from year to year. Even climatic conditions and the length of the growing season are dependent in a measure on drainage. The prevention of the spread of noxious weeds is also impossible where drainage conditions are unfavorable.

The province of Manitoba contains within its boundaries the outlet system of a vast watershed, stretching from the Rocky Mountains to Hudson Bay. Lake Winnipeg—713 feet above sea level—acts as a collecting basin for the run-off from the great agricultural areas of this watershed (including all the arable land in Manitoba) and so we may regard this lake as the ultimate outlet for agricultural drainage in the province. A ridge crosses the province running northwest and southeast. West of this ridge the land continues at a higher elevation through to the Rocky Mountains. From the foot of the ridge eastward the elevation falls off from about 1,000 feet above sea level down to the level of Lake Winnipeg. The Assiniboine River cuts a wide valley through this ridge and with several other smaller streams divides it into four parts, known respectively as Pembina, Riding, Duck and Porcupine Mountains. The Red River, like Lake Winnipeg, lies in a trough, the land sloping toward it from both east and west, and the river through its tributaries forms the natural outlet of the major portion of Manitoba's arable land. The Assiniboine, running rapidly down the hillside, has cut out a valley for itself and in its lower stretches frequent overflowing has built up a bank on either side extending a mile or two from the river and several feet higher than the land farther back. Consequently, in flood season, the Assiniboine in its lower course may be higher than adjacent lands and cannot be used for draining such lands without risk of serious flooding.

The precipitation (rain and snowfall) in Manitoba is not great, ranging from 15 to 20 inches a year, and there is barely sufficient for the needs of the crops. We are safe in assuming that land here is never seriously damaged by water that falls on it, but entirely by that which flows over or accumulates on it from adjoining lands. The principle of drainage is not to deprive the land of useful water but to so control the flow of surface water as to prevent damage and conserve moisture for the crops. In the Winnipeg district, on an average of the total annual

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