Class 4.—*Spans from 80 to 135 feet.*—We use the riveted Pratt high truss with a horizontal top chord, also with a reinforced concrete floor.

Class 5.—*Spans over 135 feet.*—We use a Pratt riveted high truss with a curved top chord. Practically all of these larger spans are also built with a reinforced concrete floor. Very seldom do we use a pin connected truss, either for Class 4 or 5, probably not once in twenty-five cases.

From our cost figures on all bridges so far constructed, we find that for any span the price erected (including substructure and superstructure) figures out very closely to $40 per linear foot of the over-all span. Reinforced concrete floors average about 20 cents per square foot. Steel in plate girder and truss spans averages from $25 to $70 a ton erected, and I-beam spans figure from $50 to $60 a ton erected.

Widths of Structures.—We have adopted for widths for concrete culverts and bridges the standards recommended by the Association of State Highway Department, which are as follows:—

First Class Roads.

Culverts under 12 ft. span, minimum width	24 ft.
Slab bridges over 12 ft. span, minimum width	20 ft.
All other concrete spans, minimum width..	20 ft.
Very long bridges less if necessary.	

Second Class Roads.

Culverts less than 12 ft. span, minimum width	20 ft.
Slab bridges over 12 ft. span, minimum width	18 ft.
All other concrete bridges, minimum width.	18 ft.

Third Class Roads.

Culverts less than 12 ft. span, minimum width	20 ft.
Slab bridges over 12 ft. span, minimum width	18 ft.
Longer bridges may be, minimum width....	16 ft.

Steel bridges are built almost invariably with a 16-ft. roadway; that is, 16 ft. clear distance between trusses or rails, no matter what the class of road, although for spans under 80 ft. some 18-ft clear roadways have been built.

Abutments under practically all structures are plain concrete, as with concrete materials as cheap as we have them in Wisconsin, and with the difficulty of getting first-class workmanship in reinforced concrete foundations without constant inspection, we find that this is the cheapest type of abutment. Occasionally cement rubble masonry abutments are used, and once in many times driven steel I-beam piles surrounded by a concrete wall are used. The last type of abutment has been found to be very satisfactory and economical for high abutments on sandy bottoms, and has largely displaced the use of cylinders with steel backing. Steel backing is not allowed on any State-aid structure. The price of concrete in bridge abutments and piers averaged last year about $8.00 per cubic yard.

A large share of the trouble with bridge structures results from improperly designed foundations. A common fault is stopping work before a proper depth below stream bed is reached. Seldom should foundations extend less than four feet below stream bed, and whenever doubt as to the bearing power of the soil at that point is entertained, or as to undermining from a rapid stream, they should be carried down to solid soil or thoroughly piled. All foundation work should be inspected as the excavation is made and material is placed, not necessarily by an engineer, but at least by an honest man with good judgment and backbone. All concrete work in any part of the structure should be inspected as it is placed. Inspection of steel and workmanship on it as it is erected is not so necessary, as it can be inspected and its compliance with the specifications determined after erection at the time acceptance is to be given.

As to methods of letting the work. We have found it necessary to have open competition and sealed bids on bridge work, and by asking for mailed bids on all work have established true competition, and have to a very large extent broken up the old system of "pooling," and combinations of the bridge agents who may be on the ground at the letting. We furnish complete plans for foundations and for reinforced concrete, I-beam and plate girder spans, and all bidders submit prices on our uniform plans. For truss spans, we furnish the truss diagram showing the stresses in the truss members and the make-up of the truss members, floor system, and principal connections, and the successful bidder submits for approval the shop drawings before fabrication is commenced. For trusses, we believe the latter system is preferable to that of furnishing complete shop drawings, as it allows manufacturers to follow their standard shop practice in detailing so long as these details are satisfactory.

The proper design for culverts and bridges is an engineering problem which should always be left to engineers. Probably a State highway department can handle it more economically than can private engineers, as so many bridges will be built of one span that superstructure plans can be standardized, and even the same foundation plan may fit several bridges. The cost of designing, letting and accepting bridges in Wisconsin has averaged about 3½ per cent. of the total cost. Inspection has been paid for separately by the local units. It would probably be better to have a State inspector on each bridge, but we have gotten very good results through local inspection at probably 25 per cent. of the cost of placing a man on each job. Important jobs should have a skilled inspector by all means.

MODERN DITCH DIGGING.

Machines are rapidly supplanting manual labor in digging trenches for water mains, sewers, irrigation, etc. The illustration below, which was made from a photograph taken by Willis Chipman, C.E., of Toronto, shows one of many different types of modern trench diggers. These machines have been especially successful in Western Canada, but are gradually coming into great favor in the East, also, for all large contracts where the material to be excavated does not contain too much stone of large size. Among the many types of these machines, the best known in Canada are the Parsons, the Austin, the Harris, the Monahan, the Potter, and the Carson excavators.