to this lateral force, are loaded with over 35 tons each.

Piers No. 0 and No. 1 are not carried as deep as the similar piers of the other two designs, resulting in a large difference in value between the different structures.

Pier No. 2 (north rest pier) consists of two shafts joined by braced side webs. The bid suggests filling the space between these webs with a lean concrete at an extra cost of $7,000. This would enable the pier to withstand a heavier blow from a colliding vessel.

The pivot pier consists of a reinforced concrete cap supported by four cylinders, each 22 ft. in diameter. The bearing area is considerably less than provided by the other designs and the pressure on the foundation much greater.

Reinforced concrete shells of 1:1 1-2:3 concrete are used for piers 1 to 3 inclusive, but for all massive work, with the exception of Pier No. 5, a leaner concrete is used composed of 1:3:5 with the addition of two parts of coarser aggregate.

The superstructure has been designed for Dominion Government heavy loading on the railway track, 40-ton electric cars on the tramway, and 60 pounds per square foot on the balance of the roadway and the sidewalk.

The floor system has been designed for traction engine or motor truck similar to that assumed in Tender No. 2.

The fixed span is of the Warren type, and is 340 ft. to centre of bearings. The maximum unit stress in the bottom chord is 18,000 pounds per square inch for the west or railway truss, and 20,000 pounds per square inch for the east or highway truss. Full allowance has not been made for impact in the centre diagonals as required by the Dominion specifications, and as allowed by the other competitors. With this allowance added, unit stresses of 24,000 pounds per square inch exist in the railway truss.

Short redundant members are used to reduce the unsupported length of the vertical posts and hangers. This is not good practice, as they introduce secondary stresses in the members.

Sway frames between the trusses are not provided at all panel points as required by the Dominion specifications.

In the design submitted the swing span has sufficient lift of the ends to make the trusses non-continuous, so that they form two separate simple spans when the bridge is closed. This is a desirable arrangement if the boat traffic is so light as to require but few openings and the bridge is used almost entirely as a fixed span.

The heaviest structure of this type which has been built is the Charlestown bridge at Boston, the weight of which is about one-third that of the span under consideration. When swinging to its closed position the ends are lifted by hydraulic jacks, requiring about eight times as much work as when the ends are only lifted enough to prevent all tendency to hammer under the rolling load. The time required for operation is also greater.

To lift the ends by the centre top chord bars as is done in the design under consideration is not economical, as it requires about four and a half times the power that is required to do the lifting at the ends. The designer may claim that the toggle arrangement reduces this, but a toggle or similar arrangement can be used in either case. It is the ends that have to be lifted; and the more direct the application of power, the less is required.

A noted authority on swing bridges in a paper presented at a meeting of the American Society of Civil Engineers on April 3rd, 1907, says: "A few bridges have been built with a lifting apparatus applied at the top chord of the centre panel. This arrangement has the additional disadvantage of using a part of the structure which carries the strain while the bridge is swinging, also as a part of the lifting mechanism, which is not good practice. If the machinery parts get out of order the structure should not be affected thereby. The writer's experience with a bridge of this kind prompts him to advise its use."

In the swing as in the fixed span redundant members have been inserted between the diagonals, and sway frames omitted at four panel points where required by the Dominion specifications and good practice.

Full allowance has not been made for impact in the diagonals, and the stresses in the diagonals and chords are high.

The centre chord eyebars are stressed by direct stress and impact to 21,000 pounds per square inch. Tender No. 1 has 20,000, and Tender No. 2 16,000 pounds per square inch for the same members under the same conditions. In this design the centre eyebars have to resist the bending due to the friction at the pins or trunnions when raising or lowering the ends of the span. As the pressure between the bushing and pin is about 8,000 pounds per square inch, the friction should not be assumed as less than 20 per cent., which gives a unit stress from bending of 7,500 pounds. This, added to the direct stress and the proper allowance made for impact gives a total stress of more than 31,000 pounds per square inch, or about the elastic limit of the material.

The pressure between the nickel steel bushing and the trunnions at the centre is over 8,000 pounds per square inch. This bearing has to perform a similar service to the trunnions of a bascule bridge, although the movement is not so great. The specifications of Sir William Arrol and others allow a pressure of 2,500 pounds per square inch, and Unwin allows a pressure of 3,000 pounds per square inch on such bearings.

The centre lifting screw has a pressure of about 1,470 pounds per square inch on the thread. The specifications of B. R. Leffler, engineer of bridges of one of the large American railway companies, published in the transactions of the American Society of Civil Engineers, allow a pressure of 200 pounds per square inch on screws which transmit motion.

In this design the total weight of the bridge while swinging is carried by the drum, which is connected to a light centre casting by radial struts. We are of the opinion that this cast-iron centre has not sufficient strength to centre the bridge when closing or to prevent its being knocked out of position. It is an advantage to carry a portion of the total weight on the centre pivot, as is done in the other designs, for it assists in resisting any tendency toward lateral movement on the part of the live ring.

The drum is loaded at sixteen points, but these points are not evenly distributed, some of the spaces being about 7 feet, while others are about 26 feet. This is most unsatisfactory arrangement, as unequal distribution, on account of the deflection of the drum between points of loading, gives unequal load on the rollers; this, besides giving excessive pressure, distorts the live ring and causes the bridge to turn hard, with unnecessary wear and tear on the rollers, track and spider.

If the load is evenly distributed the pressure on the rollers would be about 14 per cent. greater than allowed by the Dominion specifications. With the uneven distribution the load would probably be about 40 per cent. greater.

The centre pivot in this design is entirely independent of the lower track and rack. They should be con-