OLD WORLD

BOX GIRDER BRIDGES

Under Surveillance

WHATEVER conclusions the engineers of the Department of the Environment reach about the 42 box girder bridges in Britain whose safety seems in doubt, the recent disasters involving bridges of this type in Wales and Australia show that there is some way to go before these structures are fully understood.

Box girder bridges are commonly of two types; a single, flat steel tube of rectangular or trapezoidal cross section which might be 70 feet in width and 10 feet deep, or a pair of smaller tubes measuring only 10 to 20 feet in width. The concrete roadway is laid over this basic support structure. Lengths of box girder, which are simply four steel plates welded together to make up the appropriate shape, are easily manufactured, and they are attached to each other *in situ* to make up the whole span.

Box girders have become important in bridge building because they require less steel than a conventional I-girder structure; they are also simple to maintain and present a clean aerodynamic profile. Furthermore, the torsional stability of box girders, in comparison with I-girders, means that load distribution is more efficient. In some conventional bridges, on the other hand, the design must allow for a considerable proportion of the load to be supported on one girder, a measure which considerably increases the amount of steel which must be used. Curved elevated roadways are in torsion even when the loading is symmetrical, and box girders offer definite structural advantages for such bridges. Lastly, the slim lines of a box girder bridge are more aesthetic (and therefore appeal more strongly to an engineer's design conscience) than those of a conventional I-girder bridge.

Despite the appearance of simplicity, the analysis of the behaviour of box girders under load is complex. The behaviour of a long plate of steel firmly bonded at the edges but in a state of compression is especially intractable; the top surface of a box girder, welded to the side plates at its edges, presents just such a problem. Compression causes an undulating distortion—buckling—which has to be calculated and taken into account in the overall design of the bridge. One of the ways of counteracting the tendency to buckle—which depends on the square of the ratio of the effective plate width to the thickness—is to weld several stiffeners along the length of each plate so that the width of plate between the stiffeners is quite small. And, of course, none of this allows for the inevitable locked-in stresses which occur during welding.

The critical parts of a box girder bridge, from the design point of view, are the regions close to the centre of a span, and those around the piers which support the girders. The arched shape of a typical span means inevitably that the top girder surface near the centre of the span is in a state of compression, but this stress is rather more evenly distributed when the concrete roadway is bonded to it. What must be taken into account, however, is that there must be a stage in construction when the concrete is setting and therefore not adding strength but merely deadweight to the structure. The second important feature is the design of the portion of the box girder around each pier support. Because of the normal reaction at the support, extra reinforcement is necessary. A steel diaphragm is welded to the inside of the box and this is reinforced again with a stiffening plate immediately above the support itself.

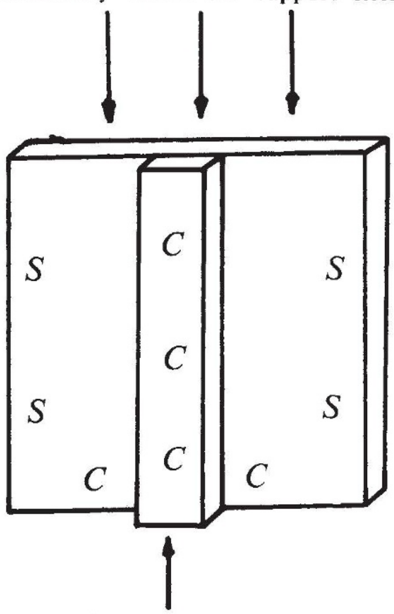

Diagram of a stiffened diaphragm (not to scale). Arrows indicate the forces acting. *C*, Regions of compression; *S*, Regions of high shear stress.

The diagram indicates the patterns of stress in the diaphragm; in the areas marked *C*, the diaphragm is in a state of compression, but at *S* the material is in a state of high shear stress which is, in turn, transmitted to the sides of the box. The evidence suggests that it was failure of the diaphragm that was responsible for the collapse of the Milford Haven bridge during construction and it seems likely that if modifications to box girder bridges are necessary in the interests of safety it will be the diaphragms and the sides of the girder in their immediate vicinity which will be strengthened.

But modifications like these mean fresh headaches for bridge builders; the true answer is to find new ways to overcome the problems in designing and manufacturing effective box girders.

TELECOMMUNICATIONS

Post Office Goes Dutch

Two years ago, the British telecommunications industry was shaken when the Greater London Council gave the contract for its new internal telephone system to the Swedish firm of L. M. Ericsson. Now it has seen an even more valuable contract—for an electronic telegram switching system—go to another foreign competitor, Philips of Eindhoven. The system, worth £3¼ million, may be the largest message-switching unit in the world. It will automatically collect, store and forward to the proper address 27,000 telegrams an hour, not only to destinations in Great Britain but overseas.

Why Philips? The Dutch-owned company, represented in this contract by its British arm, the Telephone Manufacturing Company of Dulwich, seems to have impressed the Post Office with its blend of expertise with computers and experience with conventional telecommunications message switching (some of which is now used by the Post Office for its international telegraph traffic). Computer manufacturers themselves have not so far been very successful in producing electronic telephone exchanges for use in public networks. Telephone suppliers, on the other hand, tend to be unsophisticated in computer technology. One of the British contenders for the contract—Data Communication Sciences Limited—is a company formed specifically in order to bridge the computer-telecommunication technology gap. It is owned by International Computers and Plessey Limited and the loss of the contract must be a disappointment to both.

The telegram switching system will be installed at the Post Office's Cardinal House in London. It will be based on a DS 714 telegraph computer and will replace the present electromagnetic and torn-tape methods of switching telegrams. In the former, a human telegraph operator reads the address on an incoming teletyped message, then retypes it in full to send it to its destination. The torn-tape method is an improvement in that the operator does not have to retype the message but simply to tear off the incoming perforated tape and feed it into another machine for retransmission. The computerized system will perform the whole process automatically, holding back low-rate and non-priority messages until off-peak hours.

If the contract is an achievement for Philips, so it is for the Post Office as well. The corporation has not been accustomed to commit itself to comprehensive operations of this magnitude and it may gain confidence to engage in similar boldness in the future.