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Welding in Hydraulic Engineering.

Schweißkonstruktionen im Stahlwasserbau.

La soudure dans les travaux hydrauliques.

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Hitherto welding has found relatively little application in hydraulic engineering by contrast with building work and bridges, but it may safely be said that in this special field, also, the engineer is making increasing endeavours to utilise the obvious constructional, technical and economic advantages which welding offers.

In steelwork applied to hydraulic construction there are, for instance, emergency closures, stop beams, lock gates, etc. which are mainly exposed to stresses of a purely statical character, and in this kind of work, as in building, welding is very suitable and is also economical.

In movable weirs, however, dynamic forces play a predominant part, and the phenomena which arise are even more difficult to follow than those occurring in bridges which, likewise, are exposed mainly to dynamical stresses. The dynamic forces in weirs are difficult to calculate and have not yet been fully cleared up from a scientific point of view. The barrage must be capable of being operated against the full water pressure according to requirements, and the water may flow either under or over. The whirling and rolling which attends the movement of the water, and the variations in pneumatic pressure, promote vibration which may under some conditions be dangerous. So long as the cause of these vibrations and the measures suitable for overcoming them are not fully understood it would appear advisable to make the body of the barrage as rigid and as heavy as possible.

It is true that the leading constructors of weirs, in close co-operation with universities and laboratories, have for some years been carrying out exhaustive experiments and scientific researches with a view to determining the origin of these vibrations and the means whereby they can be avoided. The results already obtained are very satisfactory. They show that by suitable design and shape and other measures it is indeed possible to avoid at least those vibrations which are likely to endanger the structure, but no complete clarification of this important problem has hitherto been obtained. The fact remains that despite all care in design and construction vibrations arise in operation, the effect of which has however, been reduced sufficiently to remove any risk of damage to the structure. In order to render these vibrations which are not yet theoretically understood as harmless as possible, the designer is compelled for the present to aim at combining a high degree of rigidity with the maximum possible inertia. Hence that reduction in dead weight which is attainable through the use of welding is not a possibility of which the engineer is at present enabled to take much advantage. For the same reason the present tendency is to avoid the adoption of high tensile structural steel in weirs, however desirable it may otherwise be on economic grounds.

For the present, then, there is no intention of constructing weirs entirely by welding, but there remain at least a few detailed members which may advantageously be constructed by this means. For instance in most of the three-boom barrages constructed in the last few years by the Dortmunder Union the end wall, booms and shutters have been welded, the remainder riveted.

The end wall if built to a welded design can easily be adapted to the cross section of the weir, and the resulting saving in weight has no effect on vibration as the wall is supported on piers.

The welded construction of the booms and gusset plates simplifies the design and gives convenient connection and simple arrangement of the staunching timbers.

For large widths the shutters must be made rigid against torsion. With welded construction the joints in the pipe provided to take up the torsional forces can easily be made and this can be connected to the remaining portions of the structure so as to be stiff against torsion. The curved form of plate covering which is necessary in order to avoid vibration can be made cheaper by welding than by riveting and in a welded plate the presence of projecting rivet heads is avoided; these would be exposed to a risk of abrasion by sand.

Apart from these dynamically stressed weir structures, welding is, as mentioned above, employed with special advantage in hydraulic constructions subject mainly to statical stresses.

The simplest statical conditions are those which arise in stop beams, and the Dortmunder Union have adopted welded construction for the stop beams in the machine house of the Albbruck-Dogern installation. These "beams" consist mainly of nosed plates with web plates. The saving in weight by comparison with riveted work was found to be about 14 % and this reduction has a very favourable effect on the design of the lifting gear.

A further example of the advantageous use of welding occurs in the lifting gate for the Niegripp lock, recently constructed by the Dortmunder Union. The main girders and the end posts are welded plate web girders built up from nosed plates and the site joints in the skin plate are riveted. The saving in weight achieved in this way by comparison with all-riveted construction amounts to about 11 %, and the counterweights are, of course, lightened by a corresponding amount, thereby imposing smaller loads on the winches and on the operating frame.

A new and particularly interesting application of welding in steel hydraulic work is provided in the floats, 10 m in diameter by 35 m high, now under construction for the ship lifting gear at Rothensee forming part of the Elbe connection on the Mittelland canal. The first of these floats is now being erected. Here again the saving in weight is considerable, amounting to abt. 10 to 12 %.

The results obtained by the application of welding to steel structures used in hydraulic engineering may not hitherto have been as conspicuous as those in bridge and building work but they are neverthess notable, for the difficulties with which this branch of engineering has to contend are particularly great.