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Disadvantages of Thin Construction in Reinforced Concrete.

Nachteile der dünnen Eisenbetonkonstruktionen.

Inconvénients des constructions minces en béton armé.

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During the last few years a number of reinforced concrete bridges, even of considerable spans, have been built wherein some of the elements are dimensioned very lightly: for instance load-carrying walls only 10 cm thick, and arches 20 cm or less. Most of this work is either in "beams reinforced with polygonal arches" or in the walls of the box sections of true arch bridges.

Desirable as it may be to build structures with a minimum of material, the adoption of excessively light cross sections in bridge work must be looked upon as a mistake in such cases as these where not only have statical conditions to be fulfilled but external influences such as weathering and frost play an equally important part in the design of the structure.

Just as a natural stone decays in course of time, so also concrete, a material usually inferior in quality to good stone, is liable to suffer from exposure to these external effects. It must be remembered that completely frost-proof concrete has not yet been produced, for even the densest concrete contains a small percentage of pores, wherein water may penetrate and frost cause damage. It is further to be remembered that many bridges cross high above valleys in positions where they are particularly exposed to wind, weather and snow, and these are influences to which special attention ought, therefore, to be paid when dimensioning the various parts. It may be true that bridges have been built without, up to the present, showing signs of damage from frost, but it must not be concluded from this that no risk of such damage exists. We have as yet no basis for estimating how concrete will behave when old and in what form the effects of fatigue may eventually be manifested, for the practice of concrete construction is still too young to afford such a basis.

It is, therefore, desirable to use the utmost caution in dimensioning, and to err on the side of liberality where heavily stressed reinforced concrete structures are concerned. Once frost damage begins to affect structural members which have been too thinly constructed a few centimetres loss of material may endanger the carrying capacity of the bridge, and especially in the case of the main supporting members of arches, it would be difficult, if not impossible, to remedy such damage; hence arches, especially, should not be made too light. Apart from the possibility that the bridge may later be subject to increased static loads, for which

it may be inadequate, there is the further consideration that bridges are monumental works which with proper materials ought to last for centuries.

It may also be recalled that in the case of heavily stressed bridge members the temporary work such as the scaffolding, shuttering, etc. costs much more than the concrete itself and this should be an additional reason for not attempting to save on the concrete. Moreover, the unit cost of concrete is higher in thin structures than in thick ones, the expenditure on such plant as service bridges, cranes, mixing machines, etc. being the same in either case, and the labour required for concreting in light constructions being much greater. Again, it is now known that very fluid concrete, such as is used in thin construction, tends to reduce the resistance to frost and this is an additional reason for avoiding excessively thin design.

The increase in mechanisation on constructional works makes it possible nowadays to produce the actual concrete at very low cost, while on the other hand the erection of the scaffolding and shuttering continues to be purely handwork. As wages increase the percentage proportion of the total cost which is attributable to the scaffold and shuttering increases, and the proportion attributable to the concrete becomes less: hence the remarkable fact emerges that in the case of thin, highly stressed bridge work the proportion of cost of the permanently stationary items is small, while that of the plant necessary during the construction of the bridge is large for the reason already discussed, and is even increasing. It follows that in bridge construction heavier designs are to be preferred to lighter. The former, moreover, are less susceptible to shock and vibration. In this matter there is much to be learnt from the old masters of bridge building, who paid special attention to making the principal part of their structures strong.

It may be true that the use of light heavily stressed structures promotes development in structural design; but in bridge work they are out of place, and such practice may lead to damage through frost greatly to the prejudice of reinforced concrete as a system of construction.