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The Thickness and Rusting of Steel Sheet Piles.

Wandstärke und Abrostung bei stählernen Spundwänden.

L'épaisseur et l'oxydation des palplanches métalliques.

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The wide usage and numerous applications to which steel sheet piling is put has led to the development, in the course of a few years, of a special science in their use which may now be regarded as an important branch of hydraulic engineering. The variety of technical knowledge has become so great that it is no longer possible for the engineer to follow developments in all branches and to be aware of the latest position in technology, or even to know what is being treated in the literature. For this reason alone, quite apart from the importance of such knowledge in public economy, everything technical ought to be expressed in a clear and simple form so as to relieve the engineer of the need for unnecessary and time-wasting cogitation.

It was, therefore, a matter for congratulation when the four leading German rolling mills agreed to adopt the same series of rolled sections for steel sheet piling. To-day the corresponding sheet piles are of the same cross section wherever produced; they have the same resisting moments and are of the same weight and quality. Likewise the freight on them is the same.

There is, however, one point which continues to cause the conscientious engineer a good deal of worry, and that is the question of the thickness of the piles in relation to rusting. There is no doubt, of course, that in the greater number of cases where engineering works have had to be renewed up to the present it has been for technical operating reasons — because the arrangement was out of date, the capacity had become insufficient, or the operating costs were too high — and seldom because the structure of the works had, in fact, become dangerous. It has always been sought to eliminate this last contingency, or at least to delay it as long as possible, and for this reason it is easy to understand why the thicker sections of piles should have been preferred.

There are many who profess to see a difference in this respect between the different sections, basing their arguments on the listed information of the producers who specify, for instance, 13 mm thickness in one case and 11 mm in another. It would, however, be a serious mistake to assume that on this account alone the first mentioned sheet pile would withstand heavy corrosion better than

the second. This should be pointed out clearly once and for all, because there are many engineers who, having to deal with sheet piling and reasoning very naturally in this way, have apprehended difficulties which were in fact non-existent.

When reference is made to the thickness of the pile it is apt to be forgotten that the flanges of these Z sections are made up of not only the listed thickness but also a large additional cross section at the interlock. If the latter were to be recalculated as redistributed uniformly over the whole width of the flange it would correspond to a strip approximately 5 mm thick, and if similar calculations were to be made for the corresponding sections of different types it would be found that this calculated or *virtual thickness is approximately the same in the corresponding sections produced by the different mills.* In order to simplify the matter it is sufficiently accurate to regard the resisting moment as being equal to the area of the flange multiplied by its distance from the neutral axis.

However, the criteria for examining or evaluating a steel sheet pile wall at the end of a life of 50 or 100 years is not the original thickness and the amount of rusting, but the *residual resisting moment* at the end of that time.

A rusting of 1 mm means the same reduction in resisting moment in *any* of the corresponding rolled sections, those rollings which are of small constructional depth being somewhat more favourably situated in this respect. The heaviest amount of rusting which is at all possible corresponds to the thinnest place in the web and if the rusting should become deeper still the sheet pile must fail at the interlock.

Fortunately the maximum bending stress which sheet piling is designed to withstand occurs in most cases at a point which lies considerably deeper than the part exposed to the heaviest rusting, so that it is possible for extensive weakening through rust to take place before the piling is in fact endangered.

Careful measurements have shown that under ordinary conditions in Europe the amount of rusting that is to be expected in the course of 100 years may be about 2 mm at the places most affected. (Compare Professor *Agatz* in the Preliminary Report.)

Knowing the smallest resisting moment that must be retained at the heavily rusted place in order that the prescribed degree of safety may be counted upon, the life of the sheet piling can very quickly be calculated, or the proper thickness of piling to give a desired length of life can be determined, thus fixing the section to be adopted. But even if the rate of rusting were in fact assumed too high this would be to the advantage of the steel.

In the course of years a consolidation of the ground occurs in the backfill, with the result that the *true* earth pressure falls off and becomes distinctly smaller than the *calculated* earth pressure which was taken as a basis for the design. This affords no justification for any great reduction in the additional margin of safety to be demanded in an old structure, in view of special circumstances, but it does mean that one need be a little less apprehensive — always provided that the load bearing members are accessible to inspection and that the material itself does not alter in its properties. In the case of steel both these conditions are usually fulfilled.

As regards the rusting itself, a clear distinction should be drawn between apparent and true rusting. Very often the flaking which is wrongly described as rust is merely thick layers of dross or other suspensions which the rusty water causes to adhere to the sheet pile, and if their thickness is recalculated as metallic iron it amounts to only a fraction of a millimetre. If, therefore, it is desired to observe the rusting on an actual job, it is essential to measure both the original and the remaining thickness.