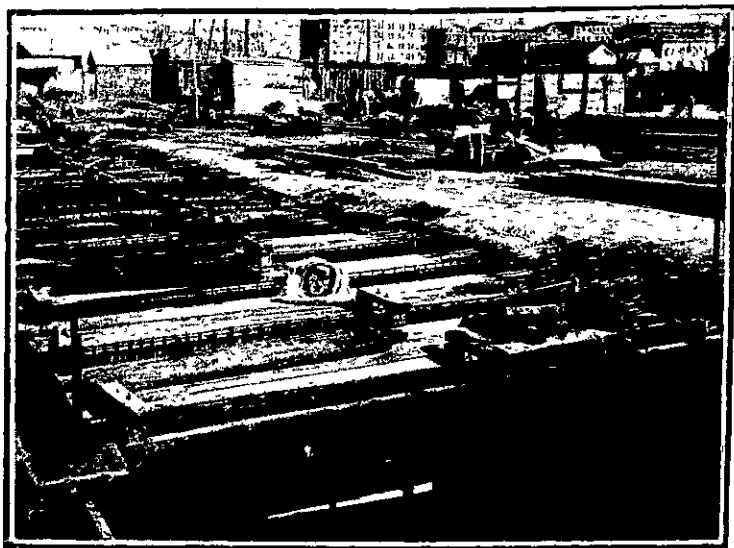




FERRO-CONCRETE WHARF CONSTRUCTION, AUCKLAND: UNDERNEATH VIEW.



FERRO-CONCRETE WHARF, AUCKLAND: VIEW SHOWING DECKING.

the compression strength being generally from 8 to 12 times the tensile strength.

The German official standards for Portland cement require that a mixture of one part cement with three parts normal sand shall show a tensile strength at 28 days of at least 227lbs. per sq. in.

It is by no means simple, however, to make tensile strength tests in such a manner as to give reliable results. Complaints in regard to the quality of cement are often due entirely to faulty testing. In the preparation of briquettes, the temperature and quantity of the water used, the character of the sand employed, and the thoroughness with which the mortar is worked, are of immense influence on the results. The strength will generally be greater the less water used; nevertheless it is always necessary to use such a quantity of water that it shall show itself on the surface of the briquette on tamping it into the mould. Long and vigorous working of the mortar increases its strength. In extensive building operations the use of mixing machines, especially pans with edge runners, is therefore highly advantageous.

CONSTANCY OF VOLUME AND CRACKING.

Strictly speaking, there is no such thing as constancy of volume, either in the case of mortar or stone, since heat and cold, wetting or drying, modify the volume more or less. Portland cement also suffers changes of volume on hardening in water or in air. In the case of good Portland cement, however, these changes are extremely small and much less than those which occur in different kinds of stone. Bad cements, on the other hand, may show the dangerous quality of cracking or swelling. This shows itself in a strong expansion, which destroys the cohesion of the mortar and may cause its total destruction.

Cement which swells badly, if laid between retaining walls, shows an immense power of expansion, even to the extent of forcing out the stones of the masonry.

The swelling does not show itself until after the setting. The worse the fault is the sooner it will appear. It shows itself, also, sooner in water than in air. In pats of cement kept under water this defect is to be noticed in the appearance of fine net-like cracks, or in worse cases in curving of the pats and the appearance of cracks around the edges. It is characteristic of expansion cracks that they run from the edges toward the centre of the pat and are widest at the edges and narrower toward the centre. These expansion cracks should

not be confused with shrinkage cracks, mention of which will be made later.

The swelling of cement is always due to defects in manufacture. These are:

1. Faulty composition of the raw material, especially too high a proportion of lime.
2. Imperfect preparation of the raw material.
3. Imperfect burning of the clinker.
4. Too high proportion of sulphate or magnesia.

According to the German official requirements, a cement is considered to be constant in volume if a pat, kept 28 days under water, remains perfectly flat and free from cracks. Swelling, due to too much lime, shows itself in this test with certainty within a few days or weeks. Cement containing too much magnesia, however, and burned to the point of sintering, shows noticeable expansion only after the lapse of long periods, extending even to several years. Only chemical analysis, or the guarantee of the manufacturer, can afford protection against the danger of expansion from excess of magnesia. Experience has shown that the presence of magnesia up to 3 per cent. is entirely harmless.

In conclusion, two other peculiar appearances may be mentioned which are often erroneously considered to indicate swelling of the cement.

It is sometimes noticed that pats of neat cement, left in air, lose considerably in strength, and after a certain time become soft or friable, while similar pats kept in water are faultless in all respects. This is especially liable to occur in the case of pats made very wet and allowed to dry out immediately after setting. If, on the other hand, the pats are kept moist during the first stages of hardening, this defect is not developed. Cracks, similar to those produced by swelling, are also produced when placed in water too soon, or before the setting is complete. To prevent this the official requirements specify that test pieces shall be kept 24 hours in moist air before placing in water.

SHRINKAGE CRACKS AND HAIR CRACKS.

Portland cement mortar without sand, exposed to the air, diminishes in volume. If the drying takes place gradually and uniformly, as in a closed room, the cement shows no defects. Too rapid drying, in draughts of air or in sunshine, without the precaution of keeping the cement moist, causes so-called shrinkage cracks. These may be distinguished, in pats of cement, from expansion-cracks by the fact that they appear during the

setting and show themselves as irregular curved lines extending over the middle of the pat. As already stated, the formation of shrinkage cracks is due to faulty use of the cement, and has practically nothing to do with its quality. Very finely ground cements are, moreover, more likely to show hair cracks than those which are more coarsely ground.

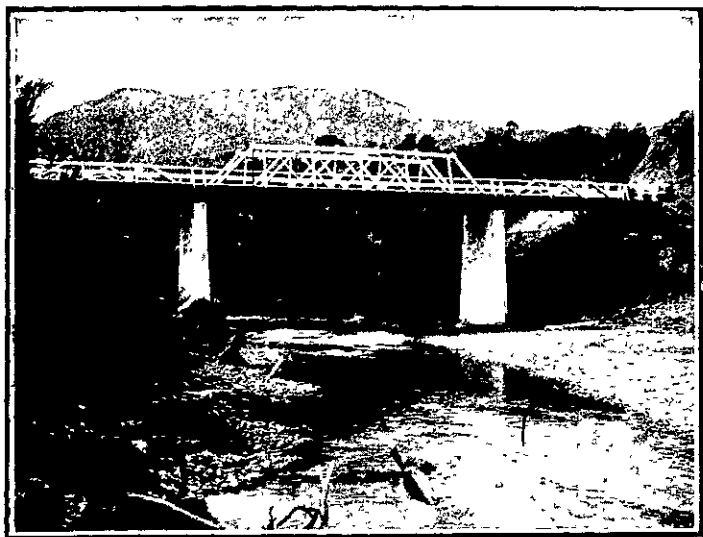
Hair cracks appear as fine lines on cement work which has stood some time. They are especially to be noticed on cement which has lain in the open air, and are due to frequent changes between wet and dry conditions. Hair cracks and shrinkage cracks occur chiefly when pure cement or mortar too rich in cement is used. They may be certainly avoided by the addition of sufficient sand and suitable treatment of the work.

(To be continued.)

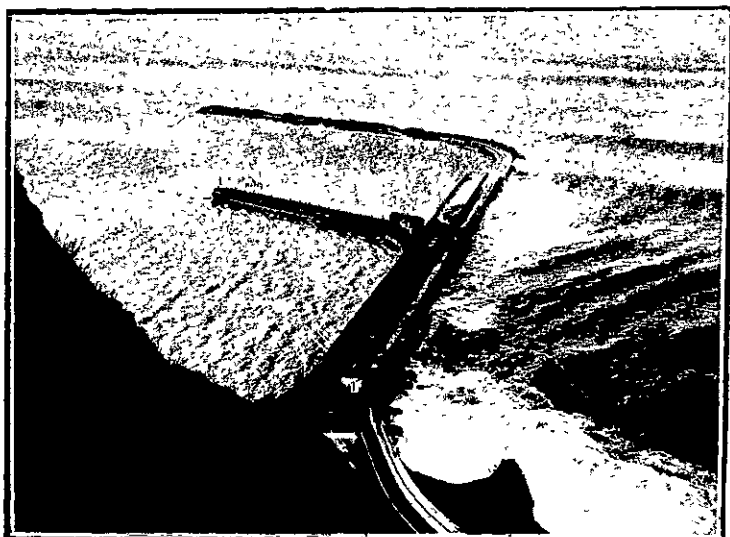
Gas-heated Baths.

The employment of gas for rapidly heating the water for baths has, according to the *Gesundheits-Ingenieur* of June 17, made great progress in the past 20 years, but many fatal accidents have arisen owing to improper arrangement of the apparatus. Mr. Schafer has found that in Germany alone 11 deaths have been caused in the past 12 years by faulty construction of heating apparatus, while in 17 cases the accidents did not prove fatal. By reference to diagrams a number of designs are given to indicate arrangements for fixing the gas-heater out of the bath room altogether, either on the floor above, or in a room beneath, or by a very simple modification of the heating apparatus it may be placed on the same level as the bath room, but in another apartment. It is pointed out that by one or the other of the above systems much greater security for life, health, and property can be secured at a very small additional expenditure.

The rails of the Mexican Gulf Railway are laid on mahogany sleepers, and the bridges built of white marble. In West Mexico is a line with ebony sleepers and ballast of silver ore drawn from old mines beside the track. The engineers constructing these railways had no material on the route, and found it cheaper to use precious materials than to import the ordinary kind.



BRIDGE OVER THE HIKUWAI: SHOWING CONCRETE PIERS.



NAPIER BREAKWATER: OVER 10,000 TONS OF PORTLAND CEMENT USED.