

venture to think from it that Mr. Fergusson's remarks are well deserved. The Mohammedan towers and minarets in India have balconies like those of other Eastern countries, and many of them are of good design, some on the other hand are decidedly top-heavy and not happy in their outlines. The modern buildings of India, like the modern buildings of all countries, are not specially interesting. Sir William Emerson and some other architects have done splendid work, and have contrived to give an Eastern character to their modern buildings, but many of the new palaces and public edifices are of very ordinary character. Perhaps these new styles are best suited to the requirements of this age, and the present buildings in their turn will be considered interesting when age has surrounded them with associations, and, no doubt, the antiquarian of some far future period will find in them an expression of the genius of our time, and of our occupation of the great and wonderful country called India.

The illustrations accompanying this article were taken from Dr. Workman's interesting book on India.

Hollow-Concrete Block Construction.

By SPENCER B. NEWBERRY

THIRD PAPER.

The accompanying table of tests of various mixtures, made by the writer, shows the good results that can be obtained with low proportions of cement,

had, almost without cost, in unlimited quantities, concrete blocks made from such a mixture would be far cheaper than lumber, and ought easily to replace all other building materials. All that is needed to bring this about is practical demonstration, and the requisite skill and ingenuity on the part of architects and builders. It is conceivable that a type of construction for small dwellings, using a 4-inch or 5-inch hollow block, might easily be developed, and these could be turned out, two at a time on 8-inch or 10-inch machines, provided with suitable cores and partition. The possibilities of development in this direction seem almost limitless.

The terms "porosity" and "permeability" are often used and by many supposed to be of the same meaning. The porosity of concrete is however the proportion of voids, or empty spaces, which it contains, while the permeability is the rate of speed with which water, under a certain pressure, will pass through it. All concretes and mortars are more or less porous, and all are somewhat permeable by water under heavy pressure. It is well known that, with the same proportion of cement mixtures of fine sand are more porous than those of coarse sand. The latter are however much more permeable than the former. Feret has shown that the porosity is the total amount of voids contained in the mass, while the permeability depends on the size of the individual openings. The least porous concrete may, therefore, be the most permeable and vice versa. If, however, both fine and coarse grains are present in proper proportion, the mass will show the least porosity and at the same time be the least permeable. The con-

even objectionable, owing to their tendency to "sweat" from the deposition of moisture on the inside surface. For health and dryness it is necessary that a gradual circulation of air through the walls should take place, and that any moisture condensing on the inside shall be absorbed and carried away.

Sufficient impermeability for practical purposes, to avoid all danger of dampness penetrating from the outside, may be secured by use of

Sufficiently large proportion of cement,

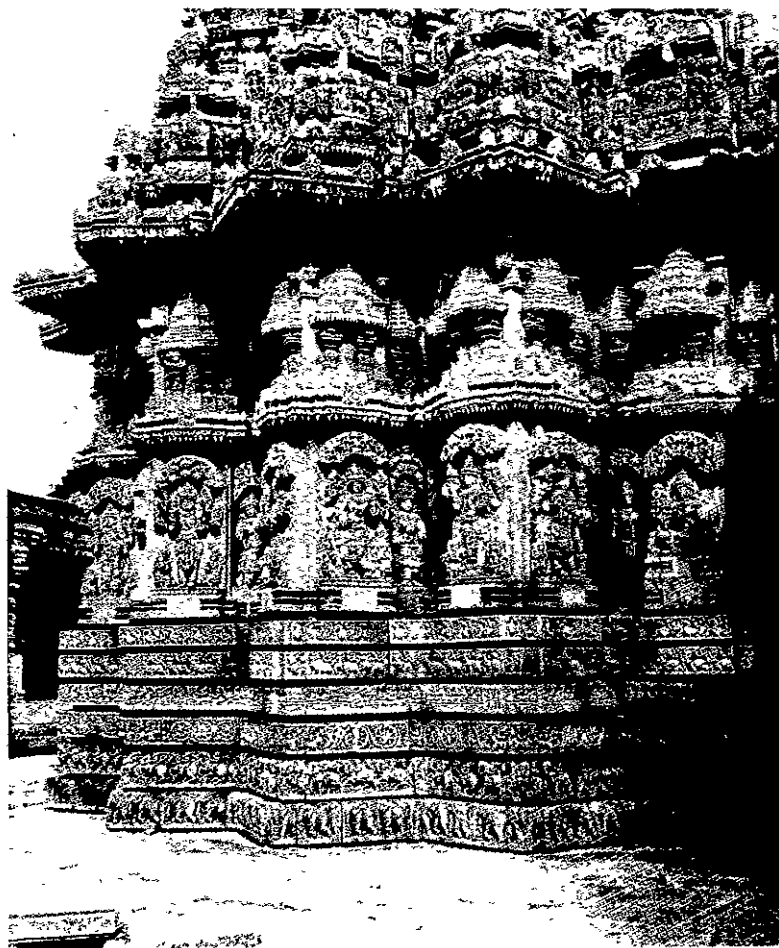
Addition of hydrate lime,

Suitable sand and gravel or screenings, containing both fine and coarse material.

With poorer mixtures, which would otherwise be too absorbent for use in the walls of dwellings, any desired water-proof qualities may be secured by the addition of a very small percentage of water-proof compound, as already explained.

COLOUR, ETC.

The experience of the writer has been that the natural stone colour, obtained by the use of ordinary sand and gravel or screenings, is more popular with purchasers of blocks than any tint which may be given by addition of pigments to the mixture. Limestone screenings give a lighter colour than most kinds of sands, but the colour is chiefly determined by the cement used, and the tint obtained with white sand is very little lighter than that with sand of ordinary grey shade. The addition of hydrate lime makes the blocks decidedly lighter in colour and the same result is obtained, in still greater degree, by making the mixture as wet as



INDIAN ARCHITECTURE. DETAIL OF ONE OF SIKRAS OF SOMNATHPUR TEMPLE.



INDIAN ARCHITECTURE. GOPURA, CHIDAMBARAM

especially with the addition of hydrate lime. It should be remembered that the compression strength of concrete is generally about ten times its tensile strength. The water absorption given is the per cent. of water, by weight, which the dry block absorbed after soaking 24 hours. The tensile strengths are the average of 4 briquettes each. The sand used was a coarse bank sand, containing very little gravel. The cost of material is based on assumed price of 6s 3d per barrel for cement 20s 10d per ton for hydrate lime and 1s per ton for sand and is stated in cents per 8-inch block, 32 in long.

It will be noted that the hydrate lime considerably decreases the water absorption, and in small proportions increases the strength. The last mixture 1 to 1 to 12, appears strong enough for all practical purposes, and is actually less permeable than the first, consisting of cement and sand, 1 to 4, without lime. It is evident that in the vast sections of our country in which sand and gravel are to be

crete which best resists water will therefore be that which is most dense, provided a sufficient amount of fine grains are present.

If a concrete block be immersed in water it will gradually absorb the liquid, and in time the amount of water taken up will be nearly equal to the total of voids present. The rapidity with which this absorption takes place will greatly differ, however, with different mixtures of the same porosity, blocks containing fine material in the right proportion will be found to absorb water much more slowly than those made from coarse materials only. It is the speed with which the water is absorbed that is of consequence in the case of concrete blocks rather than the total amount which will be taken up after a long time. If the absorption is slow, the moisture during a long-continued rain will penetrate only partially through the block, and will dry out again before the surface is again wetted. Perfectly water-proof walls are not necessary, and are

possible. The difference between blocks made fairly wet and those made too dry will be found to be very striking.

Coloured blocks, imitating various tints of natural stone, may be obtained by a facing of richer mixture to which from one to three per cent of dry mineral colour has been added. The colours most suitable are —

Red iron ore paint or Venetian red,

Yellow ochre,

Ultramarine blue

Ultramarine green

These colours are inexpensive, and may be mixed to any desired shade. It must be remembered that all cement work bleaches and whitens decidedly on hardening and drying. The colour of the freshly-made blocks must therefore be much deeper than it will appear after a few weeks' exposure to weather. Deep and strong colours are in fact difficult to secure in cement work.