CHAPTER II

VACUUM DEWATERING PROCESS

Nature of Concrete

Concrete has been exploited as a versatile and useful product for a large number of years. It is a composite material essentially composed of the water-cement paste and the embedded aggregate. The water-cement paste, the combination of the water and the portland cement, is the active part and acts as the binder while the aggregate behaves as a relatively inert mineral filler. Thus the performance of concrete is intimately regarded to the water-cement paste or, in the other words, the proportion of water and portland cement in this binding ingredient. This porportion is generally known as the "water-cement ratio".

Whenever the portland cement is mixed with water, the hydration reactions simultaneously begin to take place. These reactions are the chemical reactions between the water and the mineral constituents of the cement and the liberation of heat are also accompanied. Immediately after the cement particles have been contacted with water, the paste may be regarded as a suspension and the gel formation first takes place at that attached surface of the cement

particles. As the hydration reactions proceed, the gel takes up the originally free water and finally the increasing number of gel makes sufficiently close contact with each other forming a skeletal structure to provide rigidity.

Water-cement Ratio

The amount of the water in the water-cement paste has affected in large degree on the properties of the paste, if the cement content is to be maintained. Due to the fact that the fresh paste is a suspension of cement in water, the more the proportion of the mixing water, the more dilution of the paste and thus the greater initial spacing of the cement particles. As the capillary-pores are derived from the uncombined water, the gel framework of the dilute paste must be a porous one and results in low strength. This is why the water-cement ratio of the original mix can identify the strength of the concrete principally.

The so-called "water-cement ratio law" is essentially born out by the well-known relationship between the strength and the water-cement ratio. It states that the strength of the concrete varies principally as an inverse function of the initial water-cement ratio, provided other conditions are still unchanged.

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Basic Concept of the Process

The vacuum dewatering process is essentially one of the various techniques in which some of the excess water not required for hydration of the cement, but necessary for workability, is withdrawn by means of a vacuum subsequent to concrete placing. The principal object of the process is either to obtain greater strength without loss of workability or to obtain greater workability without loss of strength. These two concrete properties, workability and strength, no doubt come against each other such that the wet concrete, easy to handle, has less strength than do the drier one. In contrast, the greater the compressive strength of the conctete, the more difficult to work with. Thus, the method of placing concrete with excessive water, introduced for workability, and dewatering afterwards, to reduce the water-cement ratio for maintaining the required strength, is the most compatible solution of the conflict between the contractors and the consultants.

The Dewatering Equipment

The equipments available for vacuum dewatering process consist of two main parts including the concrete sealing equipment and the vacuum pump unit. The most important part that handles the end result is the concrete sealing equipment. It can be divided into two main types

based on their built-up characteristics.

The pliable mats consist of one set of filter pads, shown in Fig. 1, to be placed over the concrete surface and a top cover to enclose the filter pads to form an air chamber completely. On the top of the top cover, there appears a water outlet, shown in Fig. 2, to convey the extracted water to the water storage tank in the pump unit. Both the top cover and the filter pad are made of the continuous plastic sheet. The another equipment for vacuum sealing is the rigid plates, made from plywood backing with a filter cloth as well as a spacer net and manifolds for the water. All of these compositions are of unitary construction, contrary to the pliable mats which consist of two seperate parts. This built-up character confines the plate size to an extent of 15 square metres for handling and transporting reasons whereas the lighter top cover of the pliable mat can cover the concrete surface up to 40 square metres, generally rolled up on two pipes for ease of handling by two men only.

The vacuum pump unit consists of a vacuum pump, a water collecting tank for the extracted water, a filter for preventing everything, except water, and control equipment. All of this are generally assembled on a common frame provided with pneumatic wheels, shown in Fig. 3. The pump capacity required, at least 80 percents of maximum possible

vacuum, usually depends on the total edge length of the suction mat. This is because of the air leakage along the edge in practical work. The better the seal between the mat and the concrete, the larger area can be treated for a given pump capacity.

Dewatering Operation

This vacuum dewatering method uses the concept of the capillary action of the excess water in the concrete under vacuum, about 0.8 ksc. generally economical used. As soon as the concrete is vibrated and leveled into place, the filter pads are laid on the concrete surface to be dewatered, followed by the top cover. In order to provide the required seal against the concrete, the top cover must project beyond the filter pads by some distance, about 10 cm., on all sides. The next sequence is the commencement of the vacuum dewatering treatment and still prolongs the duration of about one minute per centimetre of slab thickness.

In operation, the water squeezed out of the compresssed concrete passes through the filter pad into the air chamber below the top cover, moves towards the suction inlet and is sucked away to the water collecting tank. The solid particles are pressed against each other with a pressure corresponding to that caused by the mat while the

water and air are subjected to vacuum.

There is no possibility of extracting so much water that there will not be enough left in the concrete to hydrate the cement because the capillary-pore diameters in the cement paste decrease as the water-cement ratio decreases. This capillary constriction begins at the surface and then proceeds downward. Wherever the water-cement ratio decreases to about 0.30, capillary diameter becomes too small to permit passage of water under the magnitude of pressure the system induces.

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