

## VACUUM DE-WATERING (VDW)

There is no doubt that by using the VDW process there is an increase in concrete strength over the same concrete without VDW.



### ***Vacuum De-Watering mats being laid***

Because fresh concrete contains a system of water filled channels, the application of a vacuum to the surface results in water being extracted from a certain depth of the concrete, this water is sometimes referred to as 'water of workability'. The final water / cement ratio at the surface is thus reduced and as this ratio largely controls the strength of the concrete and a higher strength will be obtained. However it must be noted that some of the water extracted leaves voids and as such the theoretical advantage of removing the water may not be fully achieved in practice.

It is safe to say that the increase in strength gained with the VDW system is proportional to the amount of water removed. However, this is dependent on the depth of the concrete and the mix proportions. The VDW process, if carried out over a 25 minute period, can reduce the water content by 20% but is only really effective at depths of 100 – 150mm.

Although there are some advantages with using VDW on concrete floors resulting in increased strengths, increased density and assists increase abrasion resistance, there are some disadvantages that need to be considered:

1. The withdrawal of water produces settlement of the concrete, possibly up to 3%. This can be topped up with the application of a dry shake but with little bleed water at the surface there is a risk of subsequent delamination.
2. In practice the VDW process produces voids in the concrete and it has been found that with the same water / cement ratio, ordinary concrete has been found to have a somewhat higher strength than VDW concrete.
3. VDW concrete stiffens very quickly and although this is fine in climates where VDW was first developed (Sweden) it leaves the window of workability very short in hotter climates. Workability of the concrete paste is critical when constructing a high tolerance floor for Very Narrow Aisle (VNA) warehouses.



4. Some of the finer materials are removed with the VDW process and fine sands and cement contents of greater than 350 Kg / m<sup>3</sup> should be avoided.
5. Divided liability issues need to be addressed. If for example a floor has been designed with a given concrete strength and that strength has been assumed to have a 15% enhancement from the VDW process, what happens when cores are taken from the finished slab (obviously cylinders / cube tests will only show strength of the concrete prior to VDW) and the results are below that expected? The concrete supplier will claim he has supplied concrete to the correct quality and the flooring contractor will claim he has carried out the VDW process correctly. There are also the additional costs in testing to consider.
6. One of the biggest disadvantage with the VDW system is that it is best suited for the more traditional long strip method of construction which is fine when considering the construction of superflat floors for VNA applications where the majority of the construction joints fall under the racking and out of reach from forklift traffic. However, the VDW process is not really conducive to more modern, high throughput construction techniques that have been recently introduced to the Middle East. Construction methods and equipment that have been used in Europe and the USA for nearly twenty years and have now become the common construction method for building floors for warehouses and distribution centres. By this I mean constructing floors using the Laser Screed system.



***Long Strip construction- Typically 4 – 5 m wide***

There are three parts to the design of floor slab for a warehouse of Distribution Centre:

1. Structural design (thickness of slab and reinforcement)
2. Detail design (joint layout, joint detailing and knowledge of construction method).
3. Specification – The performance requirements.

If VDW is prescribed in the specification we need to consider how it affects the three parts of the design:

### **1. Structural design**

When we design the thickness of the floor do we consider the enhanced strength of the concrete following the VDW process or not?

If we do, and design the floor as a consequence, the slab will be thinner but good quality control issues need to be put in place with regard to testing the wet concrete prior to placing and the cured concrete, in-situ, which has been through the VDW process. Also what enhancement do we use in the design?

If we do not, then this could be regarded as over designed and therefore un-economic.

### **2. Detail design**

Using the VDW process limits the construction method to the long strip system. This is a slower process compared to other methods that can be made available and increases the number of construction joints in the floor. Although best efforts can be made to hide the joints under racking and out of forklift traffic, this is not always possible and who knows how the building will be used in time. Using construction methods that reduce the number of construction joints reduces time, labour and materials all of which bring cost savings and reduced long term maintenance.

### **3. Specification**

A good performance specification should not be influenced by the construction method but by the requirements of the end user. Such as:

- Flatness
- Abrasion resistance
- Loading capacity
- Joint performance
- Aesthetics
- Curing

These issues need to be specified with a performance requirement and should not be prescriptive. As long as the contractor can provide a floor that meets the minimum performance requirements set down in the specification and they can be tested for compliance, then the client should accept any method the contractor wishes to use.

If the performance requirements are specified correctly then VDW may be considered by the contractor to achieve the requirements but it should not be prescribed.

On a final note on VDW I would like to make a personal observation. We are involved globally, designing, supervising, testing and constructing industrial floors and other than the UAE and India, VDW is rarely if ever used.

## **Modern Ground Bearing Slab Design And Construction For Industrial Buildings.**

Today, the design and construction of most industrial ground bearing slabs in the UK and many European countries are based on the guidelines within the UK's Concrete Society's Technical Report 34 (TR34). This is very much a performance based guide centring on designing and construction the floor around the end users requirements and starts with understanding how the floor is intended to be used.

First a design brief is established based on answers to the following primary questions:

- What are the loadings on the floor, UDL, line and point loads from racking?
- Is there to be racking installed? If so a layout will be required.
- Is the floor to be designed for VNA (Defined Movement) or Free Movement use?
- How flat does the floor need to be?
- What abrasion resistance is required?
- Are there any aesthetic requirements?

Secondary questions are then asked to assist in the design, for example:

- What are the ground conditions?
- Does the end user want a jointed or jointless floor?
- If the floor is to be used by VNA trucks, how will they be guided?
- Will the end user accept grinding as a method to achieve a high tolerance for VNA use?

From this information a design will be produced giving:

- The slab thickness.
- Concrete strength requirements.
- Reinforcement requirements.
- Joint layout based on proposed end use and construction methods available.
- Joint details, formed (construction) and induced (sawn). Also suggestions of proprietary joint systems for better long term maintenance.
- A flatness requirement. A DM category for VNA floors and FM for all other Free Movement Floors.
- An abrasion resistance specification.
- Any aesthetic considerations.
- A good curing regime.
- A compliance testing procedure.

Once the basic design is accepted by both the end user and the engineering consultant it will be presented to the contractor. The contractor may come back with alternatives to some elements of the design to enable a speedier or more economic approach. Compromises may be made and a final design will be agreed by all parties before construction.

The first question that is established is whether the floor is to be used as Defined Movement (VNA) or Free Movement (pretty much everything else).

If Defined Movement, then the flatness specification will be either DM 1 or DM 2 depending on the height of the racking. Then the floor will usually be constructed in the long strip method of construction, unless the client is happy to have his floor ground into specification within the aisles and therefore a Laser Screed, large pour construction method could be adopted with the Laser Grinder used to grind the aisle ways where the floor is non compliant. The only benefits of this latter approach are speed of construction and reduced number of construction joints.

If Free Movement, the floor will usually be specified either FM2 or FM2 (special) and designed to be constructed using the Laser Screed, Large pour method of construction to reduce the number of formed joints thus reduce long term maintenance costs.



***Somero SXP Laser Screed and Topping spreader- FM2(Special) 2000m<sup>2</sup> / day***

The rest of the design is usually built around the remaining performance requirements.

## **Face Consultants**

Face Consultants specialize in the design, construction and operation of warehouse and industrial floors. With over 20 years of international experience (13 in the Middle East), FACE Consultants are uniquely qualified to provide sound flooring advice to the logistics, food and other manufacturing sectors.

For new build or conversion we can assist owners and engineers at the critical design stages, advising on aspects such as floor load capacities, flatness requirements, floor joint design and construction methodology - decisions that are critical to the long term operating costs of these facilities. We have a wealth of experience in teaching contractors the skills needed in achieving performance floors and advise on equipment to achieve the same.

We offer a full Total Quality Management (TQM) system during construction, testing sub-base levels, checking joint details, reinforcement placement, concrete delivery and consistency, Floor Flatness testing and Abrasion Resistance testing.

In established facilities, we offer a comprehensive range of surveying, testing, diagnostic and condition monitoring services - advising clients on improving fork lift productivity and on repair and maintenance strategies.

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