DATAsheet

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DELAMINATION of Concrete Industrial Floors

This data sheet highlights the potential causes of surface delamination of concrete industrial floors and pavements and makes recommendations to reduce the risk of occurrence.

Delamination is the detachment of a thin (up to 5 mm) surface layer from the rest of the slab. It is initially manifested by a 'drummy' sound when the pavement is tapped or trafficked.

The cause of delamination is predominantly related to the timing of the final trowel finishing operations, which should ideally start only after initial setting of the concrete.

If trowelling (which compacts and thereby reduces the permeability of the surface layer of the concrete) is undertaken prematurely bleed water can be trapped underneath the densified surface layer forming blisters which may delaminate under subsequent surface loading.

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Delamination can also occur if surface mortar is moved by finishing equipment during final trowelling to fill 'low spots'. High angle trowel blades can cause shearing of the mortar in these spots from the concrete layer beneath. The repositioned mortar simply sits on the underlying concrete rather than bonding to it to form a monolithic slab, and eventually detaches from it.

Most causes of delamination relate to the finishing technique and its timing not being appropriate for the concrete behaviour in the particular environment, not to the properties of concrete as delivered.

It is essential that the concrete supplier be advised of the standard and quality of surface finish specified (eg burnished, super flat, 'F' and 'L' numbers, etc) at the tendering stage. Such communication may identify the need for special mix designs or different finishing techniques either of which may incur higher costs. All parties should arrive at a clear understanding of each other's responsibilities and guarantees before the project starts.

The main items which should be controlled in order to minimise the risk of delamination are:

1 UNIFORMITY OF PLACEMENT, BLEED RATE AND SETTING TIME OVER THE SURFACE

For large areas of pavement numerous truck loads of concrete are required. Consistent bleed rate and setting time between the loads are important to avoid varying finishing times over the area placed. Placing concrete progressively from one side to the other also assists in allowing finishing to proceed uniformly in the direction of placement.

The use of admixtures that impede the migration of bleed water to the surface or extend setting times of the concrete may result in the surface appearing to be ready to finish, resulting in premature finishing and increased risk of delamination.

Any use of special admixtures must consider the impact on the bleeding properties of concrete, especially the effect on the time period during which bleeding occurs and on the time/age when final finishing can commence.

Recommendations

- Uniform mix design, controlled within-tolerance slump and consistent delivery are essential. Supply from a single plant for each pour (or plants using the same materials, mix design and delivery times) is essential to ensure the consistency of the properties of the pre-hardened concrete and its finishing properties.
- Air-entraining admixtures should be used only if required. Set-retarding admixtures should be used only if required to prolong the setting time in hot weather conditions or when long travel-time is involved in delivering concrete to projects.
- Avoid specifying, ordering, requesting or allowing the use of additional admixtures that delay final finishing as these will increase the exposure of the concrete surface to drying from the prevailing weather conditions before it is ready for finishing.
- Ensure that the subbase is dense and saturated and that plastic membranes have no cuts or tears and are correctly lapped and sealed to prevent the escape of moisture from the concrete. If moisture is drawn unevenly from the concrete slab, this will result in uneven bleed or setting that in turn, can affect the surface finishing.
- Aim to achieve optimum flatness during initial placement and screeding, with less reliance on the final floating and trowelling passes to achieve the required flatness and levelness; ie avoid having to move mortar over the surface.
- Ensure uniform compaction as bleeding and settlement may increase in less compacted areas. Use vibrating screeds for vibration up to 150-mm depths, and/or poker vibrators for edges and greater depths. Poker vibrators should be inserted vertically in a regular pattern (of about 6 times the poker diameter) for a minimum of about 20 seconds.
- Reinforcing steel should be located at the correct height and supported on chairs at the recommended spacing. Top concrete cover is recommended to be in the range of 50–65 mm. If the cover to reinforcement is less than about 50 mm then vibration of individual bars or strands may compact the concrete immediately above the bar more than elsewhere, resulting in low spots along these lines. These will require filling by an early float pass, thereby risking premature finishing.
- Establish a uniform placement pattern so that concrete is always placed against the fresh face and that there are no significant setting-time differences between adjoining loads.
- Ensure that the finishing operation also follows this same pattern.

2 EVAPORATION RATE

An indicator that the concrete is nearly ready for final finishing is the absence of either water or water sheen (from bleeding) on the surface. This can be misleading if the rate of evaporation of water from the surface is greater than the rate at which the bleed water is rising to the surface, the surface will appear dry and firm enough to give the impression that the concrete is ready for finishing. This may lead to premature finishing and the risk of delamination.

Recommendations

- Ensure that climatic factors such as wind, sun, and ambient temperatures that affect the evaporation rate and finishing times are similar and uniform over the entire surface. Sun and wind tunnels will increase the rate of evaporation and may cause localised premature crusting on the surface, making a uniform finishing operation difficult. Once the surface shows signs of drying and/or crusting the time at which bleeding ceases is difficult to determine.
- Reduce the evaporation rate of bleed water from the surface by the use of fog misting or an evaporation retarder such as aliphatic alcohol. Ensure that the product is applied as a fine mist after bull floating and thereafter as necessary up until final finishing to delay the drying of the surface that causes crusting.

3 FINISHING PROCESS

The finishing process should match the direction of concrete placement and be undertaken at an appropriate time and rate so that concrete is finished at a consistent time after placement and not prematurely. The finishing process should be planned and controlled by a documented work procedure and objective evidence of compliance that ensure the stated direction of finishing matches that of placement.

Recommendations

- Ensure that all finishing processes are performed by competent personnel, experienced in operating the equipment and achieving the finish required. The finishing contractor should be able to provide examples of previous work.
- The following finishing practices are recommended:

  Initial floating – Bullfloating removes ridges of mortar formed by the screeding operation and improves the finish by closing minor holes in the surface. It should be completed prior to any bleed water appearing on the surface. Excessive bullfloating will increase the risk of delamination.

  Final floating – Final floating should not commence whilst bleed water is present. The first pass of final floating is to flatten the surface. This should be done as late as practical and in a manner that ensures the surface is not closed, trapping rising bleed water or pockets of air.

  Plan, test and float areas as they become ready. Usually a maximum 3-mm deep boot imprint in the concrete surface indicates the correct time to commence floating. *If the equipment is 'throwing paste', floating should be delayed until further stiffening of the concrete occurs.*

  It is a good and common practice to use a walk-behind power floating machine for the initial pass to aid surface levelling before commencing with ride-on pan floats. Ride-on equipment when fitted with pan floats can exert less pressure on the slab surface allowing early access. This may increase the risk of starting the final finishing process prematurely.

  Trowelling – The first pass should be with blades as flat as possible to avoid moving the surface mortar around. Finishing blades are tilted at greater angles for successive passes (as the concrete stiffens) to gradually increase the compaction of the surface layer. Rapidly increasing the blade angle can cause tears or blisters on the surface. Sufficient time should be allowed between passes for the water that has been squeezed to the surface to evaporate. If blisters or tears form while trowelling, the tilt-angle of blades is too great and a magnesium float or a flat trowel should be used to immediately push down and rebond the mortar to the concrete.

  Water should not be applied to the surface to aid the movement of finishing equipment or to achieve the filling of minor holes in the surface.

  Equipment should not be 'parked' on the surface.

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