Curling

This Flooring Technical Note considers the causes and implications of curling in slab on grade construction in concrete industrial floors and highlights best practice methods to assist in minimising the potential for curling.

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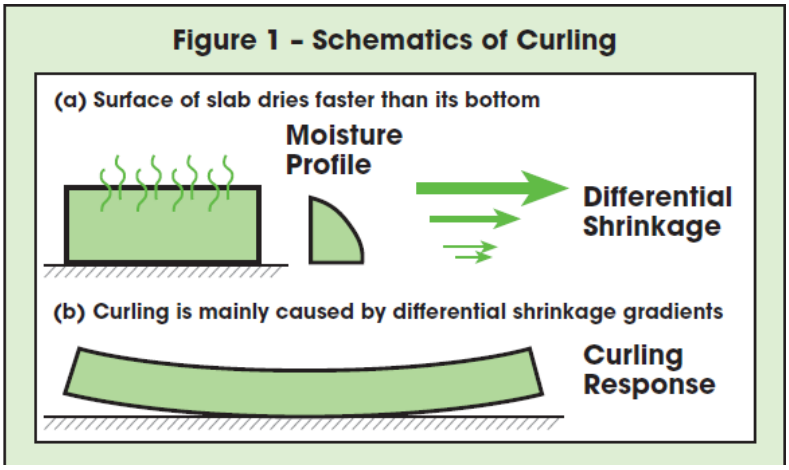
Introduction

This Flooring Technical Note covers the issue of curling in slab on grade construction is a major contributor to cracking in concrete slabs, which leads to higher maintenance cost and reduced service life. Curling becomes a bigger problem when installing super-flat floors. For indoor concrete slabs, curling is almost always caused by a differential moisture gradient in the slabs.

As the surface of the concrete slab dries faster than its body and bottom, a differential moisture profile is developed along the thickness of the slab. The surface of the slab shrinks more and quicker than its bottom. This differential drying shrinkage gradient is what causes the concrete slab to curl. The greater the gradient is, the greater the curling. If the curled edges are loaded, such as by forklift trucks, the unsupported curled edges may crack.

Then the crack becomes a maintenance problem. If the curled edges do not crack, they still can be a problem. Vehicles carrying loads may be affected as they encounter the curled edges or, in high bay warehouses, forklifts may not correctly meet the pallets in upper racks. Figure 1 illustrates the curling process.



Thin slabs and long joint spacing will potentially increase the risk of curling and for this reason applications such as thin unbonded toppings need to have close joint spacings. This issue of close joint spacings can be undesirable in large industrial floor slabs because of, as previously mentioned, the increased risk of joint breakdown and increased maintenance.

Commentary

The following practices will assist with minimising the potential for curling:

- Using the lowest practical water content in the concrete mix by incorporating high range water reducers or superplasticising admixtures
- Take precautions to avoid excess bleed in the concrete mix
- Using the largest practical permissible aggregate size
- Avoid a higher than necessary cement content in the mix
- Cure the concrete thoroughly
- Consider joint spacings and joint arrangement
- Consider appropriate load transfer across joints
- Consider the use of shrinkage reducing admixtures

Summary

Concrete slab on grade tend to curl at joints and around the perimeter, causing problems in industrial and commercial projects. As a result there is a risk that floors may deteriorate over time and in service, causing safety problems and requiring repairs. Although it may be possible to repair most slabs, curling can be minimised by careful control of the concrete mix design and handling. The repair options available depend on the service conditions and the severity of the problem.

Further Reading

Suprenant, B. A. and Malisch, R.W. *Repairing curled slabs.* Concrete Construction, Vol. 9, pp. 58–65 (May 1999).

Tazawa, E. and Miyazawa, S. *Autogenous shrinkage of concrete and its importance in concrete technology, creep and shrinkage of concrete.* Proceedings RILEM conference on high performance concrete, Sapporo, Japan, pp. 159–68 (1993).

R. F. Ytterberg, *Shrinkage and Curling of Slabs on Grade, Part II-Warping and Curling,* ACI Concrete International, pp. 54-61, (May 1987).

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Part-funded by CITB