Curling of Concrete Slabs

1. WHAT is Curling?

Curling is the distortion of a slab into a curved shape by upward or downward bending of the edges. This distortion can lift the edges of the slab from the base, leaving an unsupported edge or corner which can crack when heavy loads are applied. In other cases, slabs may curl over an extended period.

2. WHY Do Concrete Slabs Curl?

Typically, upward curling of the edges of a slab is caused by shrinkage or concentration of the top relative to the bottom. When one surface of the slab changes size more than the other, the slab will warp at its edges in the direction of relative shortening. This curling is most noticeable at the sides and corners.

Change in slab dimensions which lead to curling are most often related to moisture and temperature gradients in the slab. One primary characteristic of concrete which affects curling is drying shrinkage. The most common occurrence of curling is when the top part of the slab dries and shrinks with respect to the bottom. The slab edges curl upward (Figure 1A). Immediate curling of a slab is most likely related to poor curling and rapid surface drying; and anything that increases drying shrinkage will tend to increase curling.

In slabs, bleeding and poor curing both tend to produce potential than the concrete in the bottom of the slab. Bleeding is accentuated in slabs on polyethylene or topping mixtures placed on concrete slabs; and shrinkage differences from top to bottom in these cases are larger than for slabs on an absorptive subgrade.

Thin slabs and long joint spacing tend to increase curling. For this reason, thin unbonded toppings need to have a fairly close joint spacing.

In industrial floors, close joint spacings may be undesirable.
because of the increased number of joints and increased joint
maintenance problems. However, this must be balanced
against the probability of intermediate random cracks and
increased curling at the joints.

The other factor that can cause curling is temperature
differences between the top and bottom of the slab. The top
part of the slab exposed to the sun will expand relative to the
cooler bottom causing a downward curling of the edges
(Figure 1B). Alternatively, during a cold night when the top
cools and contracts with respect to a warmer subgrade, the
curling due to this temperature differential will add to the
upward curling caused by moisture differentials.

3. HOW To Minimize Slab Curling

The primary factors controlling dimensional changes of
concrete which lead to curling are drying shrinkage,
construction practices, moist or wet subgrades, and day-night
temperature cycles. The following practices will help to
minimize the potential for curling:

1. Use the lowest practical slump and avoid adding
retempering water, particularly in hot weather.

2. Use the largest practical maximum size aggregate and / or
the highest practical coarse aggregate content to minimize
drying shrinkage.

3. Take precautions to avoid excessive bleeding. Use a damp,
but absorptive, subgrade so that all the bleed water is not
forced to the top of the slab.

4. Avoid using polyethylene vapour barriers unless covered
with a least 25-50mm of damp sand.

5. Avoid a higher than necessary cement content if the
subgrade is wet in service. Dense, impermeable concrete will
produce larger top to bottom moisture differentials and curl
more. Use of fly ash is preferable to a very high cement
content, and consideration should be given to specifying
strength at 56 or 90 days.

6. Cure the concrete thoroughly, including joints and edges. If
membrane curing compounds are used, apply at twice the
recommended rate in two applications at right angles to each
other.

7. For floor areas where curling tends to be a problem, cure
the concrete with a heavy wax floor sealing compound of the
type used on terrazzo. (Note: Tile adhesives will not stick to these materials.)

8. Use a joint spacing of approximately 25 to 30 times the slab thickness (see table below).

9. For thin toppings, clean the base slab to ensure bind and consider use of studs and wire around the edges and particularly in the slab corners.

10. Use a thicker slab.

11. The use of properly designed and places slab reinforcement may help reduce curling.

12. Use dowels when placing a slab adjacent to an existing slab.