Publication #C01H084

Problem Radial cracks around columns

A pattern of cracks that includes radial cracks originating at the column and circumferential cracks at some distance around the column

Causes

Cracks in supported concrete slabs are usually the result of normal and expected behavior of a reinforced concrete structure due to shrinkage and deflection. In a two-way slab system (slabs supported by columns only, without beams), cracks in the slab soffit generally will occur at the middle of the slab span. The cracks on the top surface of the slab will be located usually next to or around columns.

Certain patterns and wider cracks may indicate a structural overload. The typical pattern of these cracks is radial cracks originating at the column and circumferential cracks around the column at a distance approximately equal to the depth of the slab. If these cracks appear to be more pronounced and wider, it is probable that the as-built capacity of the slab is below the actual loads (including self-weight) applied to the slab.

This overload may be caused by loads for which the slab was not originally designed, by inadequate design, or by construction deficiency. Construction deficiencies could include inadequate concrete strength or early removal of forms before the concrete achieved the required strength. The as-built depth of the slab could be less than designed or the top mat of slab reinforcement may have been improperly placed. A variation of 1 or 2 inches in the elevation of the bars could reduce shear or flexural capacity of the column-slab junction by 20 to 30%.

Does it need to be fixed?

Although the applied loads may be larger than originally anticipated, or the slab and its reinforcement may not have been built as designed, retrofit still may not be required. The as-built capacity will be higher than the design capacity if the actual concrete strength is higher than the specified strength. If the actual location of the reinforcing in the slab and the as-built slab dimensions are used in the analysis, the slab may be found to have higher capacity than designed. Finally, if the analysis shows a slight capacity deficiency, say 5%, a small reduction in the safety factor of the structure may be acceptable.

Cure

If analysis determines that there is a deficiency that needs to be corrected, there are several approaches. One is to increase the thickness of the slab with a concrete overlay and supplemental slab reinforcing. Unfortunately this also will result in additional weight and may not be effective. Additional slab thickness can be provided on the slab soffit by installing a drop panel. Additional reinforcing bars can be installed in grooves cut in the top surface of the slab around the column, but these bars usually will not go through the column, which limits the effectiveness, and the patched grooves may affect durability.

An often-used retrofit technique is to install concrete shear collars or steel brackets on the underside of the column-slab junction. This repair increases the capacity of the connection by increasing the perimeter of the load transfer from the slab into the column. It also reduces the clear span of the slab between the columns, which results in reduced bending moments and reduced stresses in the existing top-of-slab reinforcing. For this to be effective, the connection of the concrete shear collar or steel brackets to the column must provide for a transfer of vertical slab loads into the column.

Cracks radiating from a supporting column are a structural failure indicating that the slab is overloaded.

References

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