

Problem Popouts

Pits left in the concrete surface after a small piece of concrete has broken away because of localized internal pressure.

Causes

Most often, popouts are caused by pieces of porous rock, such as chert, weathered dolomite, or shale, that are highly absorptive and have a relatively low specific gravity. These aggregates may become saturated by the water used to make the concrete or may absorb enough water after concrete placement to become saturated. When the saturated aggregate particle freezes, it either fractures due to internal pressure or pushes enough water into the mortar cover to cause the mortar to pop off. Popouts typically range from about ¼ inch to several inches in diameter, and usually a portion of or all of the aggregate that caused the popout remains at the bottom of the hole.

Some popouts are caused by contaminants within the concrete such as coal, clay balls, or wood particles. These contaminants absorb water, swell, and cause a popout, with or without freezing. Popouts can also be caused by alkali-silica reaction (ASR) within the concrete. In this case, aggregates containing some forms of silica react with the alkalis in the portland cement to produce a gel. If this gel absorbs water, it swells and can produce popouts. This type of popout may involve the fine

aggregate and may be seen very soon after concrete placement.

Prevention

To prevent popouts where the cause is not believed to be ASR, take the following steps (Refs. 1 and 2):

- Avoid using aggregates that are suspected of causing popouts. However, even aggregates meeting the applicable ASTM standards may contain enough deleterious particles to cause some popouts. To determine if locally available aggregates are susceptible to popouts, look at the performance records of aggregates in your area.

- Use beneficiated aggregates (aggregates treated to remove lighter parti-

cles) if they are available in your area. Some highway departments use this type of aggregate for concrete handrails and other structures they wish to be free of popouts. The cost for such aggregates usually is higher than that for normal concrete aggregates.

- Select smaller maximum aggregate sizes because smaller aggregates often are less prone to freezing problems. However, don't forget that use of smaller aggregate will increase paste requirements and may increase drying shrinkage.

- Consider increasing the depth of cover by forcing the coarse aggregates deeper into the concrete using a jitterbug. But be very careful with this procedure; though it can reduce

popouts, it can also create conditions that lead to other problems such as abrasion damage or surface crazing.

- Improve concrete quality by using a lower water/cementitious-materials ratio to decrease mortar permeability and increase strength so the mortar can resist the forces exerted by the swelling aggregate particles.

- If you have a critical floor application where popouts can't be tolerated, consider using a two-course construction scheme with the top course containing only crushed aggregate known to perform well.

If the popouts are related to ASR, you can minimize them by taking steps that reduce this reaction, including:

- Using a suitable pozzolanic material in the concrete

- Using a nonreactive aggregate

- Using a low-alkali cement



Popouts are ¼ inch to several inches in diameter, and usually a portion of aggregate remains at the bottom of the hole.

References

1. George Verbeck and Robert Landgren, "Influence of Physical Characteristics of Aggregate on Frost Resistance of Concrete," Proceedings, ASTM, Vol. 60, 1960, pp. 1063-1079.
2. Ward R. Malisch, "Avoiding Common Outdoor Flat-work Problems," CONCRETE CONSTRUCTION, July 1990, pp. 632-638.