

ARM of Minnesota

**Causes of
Aggregate
Popouts in
Minnesota
Concrete**

ARM of Minnesota

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AGGREGATE & READY MIX
ASSOCIATION OF MINNESOTA

Popouts

Popouts are surficial defects which occur in concrete, typically characterized by a conical failure with an aggregate at the base, while leaving the remainder of the paste intact. Sometime the aggregate fracture occurs within the particle itself, other times the paste above the aggregate is removed due to swelling, exposing an aggregate piece. This should not be confused with scaling or mortar flaking, which are failures of the paste, but rather popouts are due to the properties of the aggregate.

Most of the gravels found in Minnesota were deposited during the last period of glaciation. These materials contain a mixture of rock types from our northwest and northeast, which is the rough direction of the glaciers which covered Minnesota some 10,000 to 15,000 years ago.

More than 98% of the particles within these gravels are hard and durable with respect to freezing and thawing. There are some particles, such as shales, cherts, iron oxides and some carbonates for example, which are not. These are present in trace quantities in almost all glacial aggregates.

As a result, some of the particles contained in concrete are not durable with respect to freezing and thawing. The stresses developed within the aggregate itself by the freezing of water contained in the spaces inside the rock cause it to expand. This can cause fracturing in the surrounding concrete and result in a popout.

The quality of aggregate in Minnesota is often set by the MN/DOT specification for coarse aggregate for use in concrete pavements, or the American Society for Testing and Materials (ASTM) C33 specification for concrete coarse aggregate. Both of these documents recognize the economic impossibility of removing all of the popout-causing material. For example ASTM C33 Class 5, Architectural Concrete, Class S Severe Weather Exposure, which covers all of Minnesota, still allows a fraction of the aggregate to contain particles which are not freeze/thaw durable. Similarly, MN/DOT Specification 3137 allows the same.

Even with aggregates conforming to ASTM C33 5S and MnDOT 3137, popouts can occur in the 20-30/yd² and 15-20/yd² range, respectively, for **all glacial gravels found in Minnesota**. Aggregates conforming to MN/DOT 3137 Superstructure as well as 3137 Class A can reduce popouts to 5-10/yd² or

less. Some crushed bedrock, such as selected carbonates, have a very good performance history. These materials can be used to substitute for Class A aggregate where the performance history is known.

We have all seen concrete that does not contain concrete popouts. This is because gravel deposits are variable in nature. In some locations in gravel pits, where the aggregate was deposited by standing or moving water, some sorting may take place, and as a result, there may be very few popout-causing particles in some areas of the pit. Similarly, the freeze/thaw exposure level may vary from location to location.

Popout occurrence is a normal part of concrete, manufactured and used in exterior flatwork in Minnesota, and is not indicative of poor quality or construction practices.

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