THE ORIGIN OF NATURAL GRAVEL DEPOSITS AND THE EFFECT OF CRUSHED PARTICLES ON AGGREGATE STABILITY

The Michigan Department of Transportation currently has specification requirements for 26 different coarse and dense graded aggregates. They are used in portland cement concrete for roads and structures, for bituminous pavements, for bases under concrete and asphalt roads, for gravel roads and shoulders, and many other uses. Each aggregate class is designed for specific uses and has separate physical requirements, one of which is the percent of broken or crushed particles.

An aggregate, by definition, is a manufactured material. Aggregates in Michigan are made from natural gravel deposits, stone quarries, blast furnace slag, steel furnace slag, reverberatory slag from copper smelting, and crushed concrete.

Except for quarried aggregate, crushed concrete and slag, the crushed content of the various aggregate classes will vary widely. Aggregates derived from natural gravel sources are a product of the action of continental glaciation. The glacial ice, as it slid and ground its way across the land surface, picked up, ripped out, and plucked pieces from the exposed bedrock surface.

These rock pieces and fragments became incorporated into the bottom part of the ice mass. As they moved along with the ice, they were broken, ground, and some were reduced in size from boulders to various sizes of rock, sand, and gravel. As they moved along in the meltwater streams and rivers flowing from the melting ice, their sharp edges quickly started to become smoother. Studies have been made as to the type of crushed face and edges (fresh face, sharp edges vs. smooth face, rounded edges) that are necessary to achieve the desired stability. The results have indicated that fresh fractures with rough faces and sharp edges yield the greatest stability. Incidentally, it isn't important whether a rock particle has been fractured by glacial action or by a crusher at a gravel plant. The origin of the crushing should not be a consideration when picking aggregate particles for crushed content.

The term pick or picking is used when individual aggregate particles are identified and separated from a sample for one specific purpose. There are picks for crushed content and picks for deleterious (poor aggregate) content. The proper way of picking crushed particles is an important part of aggregate testing and quality control. The crushed requirements of a particular aggregate class are put there for a reason and constitute a critical part of an aggregate's composition.

When edges are more rounded and fractured faces are smoother, the stability, although better than fully rounded, significantly decreases. Therefore, a crushed particle as defined for MDOT procedures is one with a freshly fractured face with sharp or slightly blunted edges. It is noted that very sharp edges begin to become blunted with handling. This is particularly true of relatively soft particles such as limestones and dolomites. If the edges are only slightly blunted, but not rounded, they should be picked as crushed.

A rock particle with a chip or small fracture on one side does not constitute a crushed particle. The fracture must involve a significant part of the particle. This is a judgment call. As a guide, if the rock particle is held so that its fractured face is viewed directly, the fractured part should constitute at least 50 percent of the outline of the rock particle. Depending upon the particular class of aggregates, an individual aggregate particle may be required to have at least one or at least two crushed faces.

In picking for crushed particle content, the aggregate is separated into two piles of obviously crushed and obviously uncrushed particles. This leaves a third pile which is questionable. One-half the weight of this questionable pile is then added to the weight of the crushed pile and the other half added to the weight of the uncrushed pile. Experience has shown that the weight of the questionable pile should be less than 20 percent of the weight of the total sample.
One exception to the crushed particle identification is sandstone. Regardless of its shape, a sandstone particle is always picked as a 100 percent crushed particle. This is because the individual sand grains in the sandstone act like crushed particles or like sandpaper would act against an adjacent particle.

It is evident that an aggregate is a very special manufactured material. Depending upon its uses it can have varied physical requirements of gradation, crushed content, deleterious limitations, and other such requirements as freeze-thaw durability not mentioned in this article.

---

**IMPORTANT UPDATE!**

Subsequent to publishing the article RESTRICTION ON FOREIGN MATERIALS in the last (Issue No. 22) MATES, an advisory was received from the Federal Highway Administration clarifying the official interpretation of a 'foreign product.'

Two examples were given in our MATES article as to the interpretation of the term 'product.' The first example defined portland cement concrete as a 'product,' rather than any of its constituents; therefore, if portland cement costs less than half the cost of the concrete, foreign cement could be used. The second example involved the use of a Japanese reflective sheeting material for signs. We interpreted the sign to be the finished product, and its cost would include the wood or metal backing, the labor to build it, and the sheeting. Thus, if the foreign sheeting cost less than 50 percent of the total sign cost, it could be used.

The Federal advisory apprises that this is only partially correct. In the first example cited above, if the contractor or subcontractor buys ready-mixed concrete, use of foreign cement would be permissible providing it constituted less than 50 percent of the cost. If, however, the contractor manufactures his own concrete, purchase of foreign cement would not be allowed, as the foreign cement is now the purchased product. In the second example; again, if the complete sign is purchased for erection by the contractor or subcontractor, it is permissible to use the Japanese sheeting providing its cost is less than half the cost of the sign. On the other hand, if the sign fabricator is the prime contractor or a subcontractor, the reflective sheeting used for the sign would be the product, and would not be acceptable if made in Japan.

---

**“HOT-MIX BITUMINOUS RECYCLING – MAKES SENSE AND SAVES DOLLARS!”**

Much has been written concerning bituminous pavement recycling and the effect it's had on modern paving practices.

---

**TECHADVISORIES**

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

---

**NEW MATERIALS ACTION**

The New Materials Committee recently:

Approved the following products:

- Rawl Chem Stud for Concrete Anchors
- Tiger-Tite Locking Rings and Pliers for Gabions
- Grade Adjustment Rings for Manhole Covers
- MSU #360 Alu Poly Manhole Step
- Drainage Filter Sock by Syflico

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely dissemination of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

---

It should be noted that some products may have restrictions regarding use. For details please contact Don Malott at (517) 322-5687.

**Technology Transfer Unit**

Materials and Technology Division

Michigan DOT

P.O. Box 30049

Lansing, Michigan 48909

Telephone (517) 322-1637

---

---

---