Abridgment

Effects of Abrasive Size, Polishing Effort, and Other Variables on Aggregate Polishing

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Although pavement skid resistance is subject to cyclic changes, there is a gradually diminishing overall decrease and an eventual leveling off of the minimum, which depends on the surface aggregate, traffic, and the like (1). Because the skid resistance level is primarily a function of the reduction of the microtexture of the surface aggregate, six typical rock samples were polished in a reciprocating polishing machine (2) to equilibrium (6000 passes). To eliminate the effects of aggregate shape, size, gradation, and edge effects, 100 by 150-mm (4 by 6-in) flat surfaces of rock were employed. Friction was measured with the British portable tester according to ASTM E 303. Eight grades of silica abrasive (Mohs hardness 7) were used. Thin sections were made to identify the rock properties (Figure 1).

Figure 2 shows the results obtained. With the Valentine limestone, the polish becomes smoother as finer abrasive is applied; this occurs independently of the order in which the abrasive grade is applied. The Hummelstown-Myerstown limestone performance is quite similar, but the friction level is lower. This is surprising because the Hummelstown stone contains 15 percent dolomite with a Mohs hardness of 3.5 to 4, and the basic calcite of both limestones has a hardness of 3. The micrographs provide the likely explanation—30 percent of the Valentine limestone consists of large crystals of sparry calcite embedded in very fine micrite and the Hummelstown stone has uniform and small grain size.

The diabase samples came from Fairfax County, Virginia, and are representative of triassic diabase, commonly known as traprock. In this case, a finding that had already been made with the limestones was confirmed—no specific abrasive size produces the highest polish of a particular type of rock. It became clearly evident that, for a given rock and prevailing conditions, the polish depends primarily not only on abrasive size but also on polishing effort (number of passes and the contact pressure between polishing pad and specimen). When a ground surface was polished with 5-μm abrasive, no change occurred, but, when a 10-μm abrasive was used, the BPN dropped significantly. Further increase of the abrasive size caused only minor changes. When the process was reversed, a large drop in BPN occurred with the 53-μm abrasive. A partial explanation of such behavior may be that the initial natural coarseness of the texture must first be destroyed before actual polishing can take place and that, depending on polishing effort and rock structure, discontinuities occur in the polishing process.

With the lithic sandstone, similar behavior was noted except that a higher friction level prevailed. Because this rock has a rough natural texture 80 percent of which consists of large quartz grains that are held together by sericite and quartz fragments, this is not surprising. Arkosic sandstone performs no differently in principle, except that it does so at a still higher friction level. Although similar in composition and structure to the lithic sandstone, it is more friable because of a softer matrix. This causes a continuous release of particles during polishing, which results in high friction.

The quartzite behavior is not basically different from that of other hard rocks, but, next to the Valentine limestone, it is the most polish-susceptible rock of this series probably because it consists of uniform mineral grains.

These observations lead us to four conclusions.

1. The level of polish attainable depends on type of rock and petrography. Rocks composed of minerals having different hardness and loose bonding, such as the sandstones, will not polish to the low friction levels of fine-grained or uniform minerals, such as limestones and quartzites.
2. Coarse-grained rocks require greater polishing effort than fine-grained ones. The grains apparently must first be flattened or rounded off before polishing begins.
3. In general, the finer the abrasive is, the finer the ultimate polish will be, regardless of type of rock.
4. The coarser abrasives tend to scratch and roughen polished surfaces of soft rocks, such as lime-

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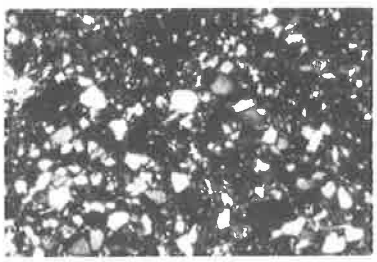
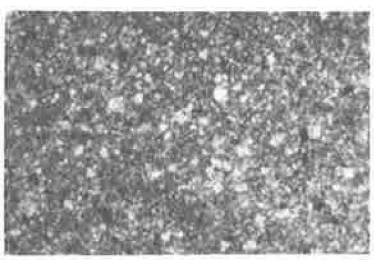
Figure 1. Thin-section photomicrographs.

Lithic Sandstone

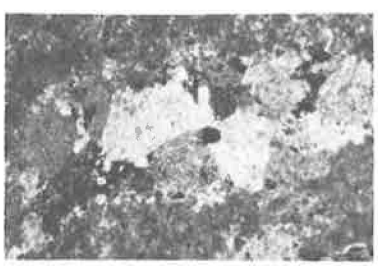
Quartzite



Arkosic Sandstone



Hummelstown-Myerstown Limestone



Valentine Limestone

Diabase

Figure 2. BPNs of polished rock surface.

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                     Abrasive Size µm
Surface     5  10  15  30  44  Mix  53  74  105
                     Valentine Limestone

1-4    25G------> 20 ----------------------┐
           21<-22<-23<-26<-29<-------29<-29<-32
           └-------->25------------->28
                 21<--------27<------┘

4-1        28<-32<-32<-34<-35<-------36<-36<-37<-39S
           └->27->26->29->34-------->35->36->35
                          33<--------------┘

4-2        19<-21<-24<-30<-34<-------34<-35<-34<-28G

4-5        28<-29<-30<-34<-35<-------36<-36<-35<-38S
           └->30->31->36->38-------->38->39->40
                          36<--------------┘

4-6    31G->28->22->23->27->35------->39->39->41
           33<--------------39<------------┘
           └->26

               Hummelstown-Myerstown Limestone
1-1    20G->10->12->11->12->16------->16->17->17
            12<-13<------------------------┘

1-2        17<-18<-19<-21<-22<------23<------25<-22G
           ↓
           15

4-2    16G---------------------------------->26
            20<----------------23<----------┘
                          Diabase
1-1    42G->41->29->27->27->27------->26->25->27
            21<-22<-22<-23<-23<------24<-27<-┘

3-1         20<-22<-24<-25<-27<------28<-31<-34<-39G
            └->23->23->22->22-------->22->25->25
            21<----------------23<-------------┘
                     Lithic Sandstone
1-1        38<-39<-40<-40<-41<-------42<-42<-49<-49G
           └->38->36->35->36-------->37->36->35
           32<----------------35<-------------┘

1-2    48G->50->48->42->43->41------->41->40->39
           34<----------------36<-------------┘
                     Arkosic Sandstone
2-1    48G->47->49->46->42->47------->47->52->55
           48<-48<-47<-46<-50<-------48<-52<-┘

1-2    83S----->68
           64<--┘
                         Quartzite
1-1        20<-21<-22<-23<-23<-------25<-27<-30<-48G
           └->20->20->20->19-------->18->19->18
           17<----------------(18)<-----------┘

2-1 43G---->31->27->24->22->22------->20->20->20
           19<----------------19<-------------┘
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Note: G = ground; S = sawed surface.

stone, but have little or no effect on hard-mineral rocks, such as diabase, sandstone, and quartzite.

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REFERENCES

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