PHB TechBullet #6

Bedding and Joint Sand

The role of sand in a sand-set paving system is often minimized on segmental paving projects. Unfortunately, poorly graded or incorrect sands compromise the strength of a sand set system: interlock. Without interlock, paver movement and contact occurs resulting in system failures with severe economic consequences in some cases.

The role of sand is key:

- The sand bed, along with full joints of sand, creates friction between individual pavers producing vertical and rotational interlock. The sand joint also plays a "cushioning" role in preventing paver-to-paver contact and resulting damage. Angular or course sand works the best in creating interlock. Round particle sand, like mason's sand, complicates this process because the particles don't want to stay together, reducing friction, leading to sand loss.

- The sand bed needs to function as a drainage layer for water penetrating through the joints. A saturated sand bed can create what Knapton and Cook refer to as a "lubricating slurry" destabilizing the bed and reducing the amount of load transfer capability. Therefore, washed sand, void of fine material (< 3% passing 200 sieve), is necessary to allow for free flow of water and the prevention of sand segregation.

ASTM C33

The vast majority of bedding specifications call for a washed, well-graded coarse sand that conforms to ASTM C33-Specification for Concrete Aggregates, commonly referred to as concrete sand. (See table 1)

In the recognition that fine particles create moisture retention problems, the gradations for bedding sand specifications generally include the modification that less than 3% of materials pass through the #200 sieve. For pavements under heavy traffic load, this requirement is often decreased to less than 1% for #200 size material.

Table 1
Grading requirements for Bedding and Joint Sand

Sieve Size	Percent Passing
3/8 in.	**100**
No. 4	**95 to 100**
No. 8	**80 to 100**
No. 16	**50 to 85**
No. 30	**25 to 60**
No. 50	**10 to 30**
No. 100	**2 to 10**

Sand hardness can play a role as well. Softer materials can break down under load, particularly under vehicular traffic, and alter the original gradation. Given appropriate conditions, care should be taken to determine the hardness of the specified sand. Sands made up of silica minerals are generally harder and more wear resistant.

Sand angularity can also be a concern particularly with manufactured, crushed rock sands or stone screenings. Even if the rock is relatively hard, Knapton and Cook found that sharp edges on sand grains would chip away as fine particles and cause the clogging of the bedding layer as cited above. They recommended only naturally occurring silica sands for heavy channelized traffic, as these particles tend to have rounded edges due to weathering.

Bedding Sands to Avoid

Mason's sand (ASTM C144) is fine sand that derives its name from the sand-cement mix used in masonry construction: mortar. Given the small nature of the particle sizes plus their rounded shape, mason's sand is not suitable for bedding sand as the sand will settle differently across the pavement causing an uneven surface and potential drainage problems.

Much debate occurs over the use of stone screenings in segmental pavements. Many practitioners use screenings regularly for pedestrian applications and some vehicular applications. As a result, these manufactured sands get used on jobs whether specified or not. Screenings typically contain a high % of fine material and are subject to breakdown over time. Given these problems as reviewed above, stone screenings are

not recommended and strongly discouraged for vehicular applications. Testing at Clemson University documents that some types of screenings (and aggregates) will cause efflorescence. Limestone based aggregates should be avoided, if possible, for this reason.

Due to the critical role sand plays in a segmental paving system, the designer may want to include specification requirements calling for sieve analysis and certification of all aggregates to be used on segmental paving projects.

Recent Sand Studies

Recent studies by ICPI on effective, well performing sands show some common characteristics although it is too early to draw definitive conclusions. Preliminary results show good performing sands have:

- Higher permeability
- Higher coarseness
- Lower shale, carbonate and chert content
- Predominance of silica content

Joint Sand

Most often, ASTM C33 is specified for joint sand because it compacts better and it is more convenient/economical to have one sand type at the job. However, there are particle sizes of C33 that will not fit into a 1/8” joint and can wedge at the joint top, preventing other smaller particles from filling the joint. In general practice, the installer works around the larger particles through extra sweeping and sand applications till the joints are full. The larger particles are then swept off at the end along with any excess sand. Some installers avoid extra sweeping by sieving the sand on-site or having the sand sieved by the aggregate supplier.

Some specifications allow a finer sand (ASTM C144) to be used to fill the joints. The main reason is that finer sand is easier to get into the joint and it helps to insure that the joints will be completely full. However due to the rounded and finer nature of the particles, joint sand retention problems can create loss of interlock, sand tracking and sand re-application. As a result, do not specify finer joint sands, particularly on vehicular pavements.

Joint Sand Retention

Joint sand naturally seals over a period of time as fine silt and debris settles in the top of the joint. There are special circumstances where encouraging sand retention is a prudent action.

Joint sand loss is the most common cause for vehicular pavement failures and the reasons are many: excessive run off, tire suction, poor drainage, inadequate bedding or joint sand, poor base design, street cleaning. Sand loss can be a problem in pedestrian applications as blowers and pressure washers can remove joint sand and prevent the natural sealing process.

Several methods have been used to prevent sand loss over the years and have proved effective given sound system design. They include liquid sealant type products, sand additives and pre-mixed sand/additive combinations. While there is scant research available on the effectiveness of different methods, the following observations seem generally accepted:

- Proper sand and application methods are critical to performance. Paving systems need to be void of any moisture prior to applying a stabilizing method and directions must be followed.

- Cement & sand mixtures are not recommended because the mixture tends to break down over time due to traffic loading and the pavers will need chemical cleaning after installation.

- Application techniques for liquid stabilizers are likely to be different than those for a general sealer. Liquid products ***may*** alter the pavement color, leave a sheen, and affect skid/slip resistance.

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