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TURFSTONE TECHNICAL NOTE

Turfstone is a concrete grid pavement product manufactured by Oldcastle under the Belgard brand in accordance with ASTM C 1319. The product is commonly used to create "green" pathways capable of supporting infrequent vehicular traffic. Turfstone is an acceptable solution for emergency access lanes and occasional fire truck loading if properly designed. Aggregate infill may be suitable in some applications. As a general rule, maximum lifetime ESALs should be limited to 7,500 and applications should be restricted to limited vehicular traffic and only occasional truck traffic.

The project engineer should confirm that Turfstone is appropriate for the application and develop a site-specific pavement cross-section. Construction drawings and design calculations for any concrete grid pavement system should be prepared and stamped by a Professional Engineer registered in the state of the project. The following base thickness suggestions are for general guidelines for typical Turfstone applications.

Minimum Dense-Graded Aggregate Base Thickness Guidelines for Turfstone

Conditions	**Subgrade Soil Types**	**Residential Loading** Driveways, walkways, paths, cart paths, trails	**Low Volume Commercial Loading** Emergency access, lightly used parking stalls
Stable, firm, dry granular soils (CBR > 10)	GP, GW, GC, SW,	**8-inch base**	**8-inch base**
Ground ruts with vehicular traffic (5<CBR<10)	SP, SC	**10-inch base**	**12-inch base**
Ground is soft, moist, and ruts easily (CBR<5)	ML, CL, CH	**12-inch base**	**16-inch base**

The subgrade soil and base preparation are critical to the performance of any pavement or paver system subjected to vehicular traffic. The subgrade soil and base, in addition to the paver product, must be able to safely transfer the load into the underlying foundation subgrade soil in a stable manner. Turfstone is capable of supporting vehicular loading, but it is up to the design engineer to ensure that an adequate base thickness is specified and verify that suitable subgrade soils are present prior to installation of any pavement product. All pavement design is site-specific and is based on actual soil conditions and anticipated vehicular loading patterns.

The following additional design and installation recommendations are suggested for any Turfstone project:

- Subgrade shall be compacted to 95% of standard Proctor density. Subgrade shall have no free-standing water.
- Base shall be dense-graded aggregate in accordance with local road base criteria and shall be compacted to 98% standard Proctor density. Cement or asphalt treated bases can be used to improve pavement performance. Base material and thickness shall be designed based on site-specific conditions as approved by the project engineer.
- A drainage geotextile chosen in accordance with AASHTO M-288 should be installed to separate the subgrade from the base material and side walls.
- A 1" thick leveling sand bed (with max. 1% passing the 0.080 mm sieve) shall be used to set the Turfstone grid units.
- Infill typically consists of topsoil conforming to ASTM D5268 for most applications. Gravel infill can be used but may not be suitable for all applications. When topsoil and grass are used in the void spaces, irrigation is recommended in most climates to establish and maintain healthy grass cover.
- Slope applications should be limited to 8:1 for vehicular applications.
- An edge restraint for all Turfstone applications is required. Commercial applications should utilize a poured in place concrete curb for containment.

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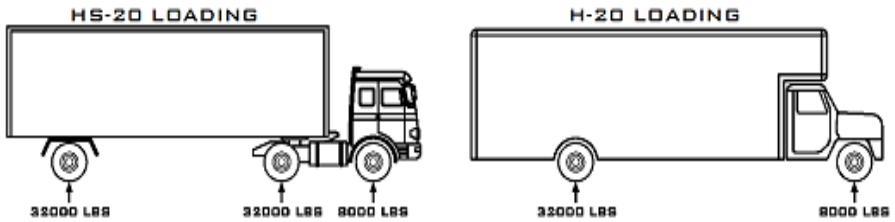
TRAFFIC LOADING CALCULATION EXAMPLE

The following calculations demonstrate that Turfstone, a permeable lattice grid pavement system used with a turf infill for vegetated applications, satisfies the requirements of meeting or exceeding an H20 or HS20 loading by comparing the theoretical design loads to the compressive strength of Turfstone.



Step #1) Determine the maximum wheel load:

W_L = 32,000 lb/ 2 (divide by 2 since there are two tires per axle) W_L = 16,000 lb

Step #2) Increase the load by 30% to account for dynamic forces associated with moving vehicles:

$W_{L\text{-}Dynamic} = W_L \times 1.30$ $W_{L\text{-}Dynamic}$ = 20,800 lb

Step #3) Determine the tire contact area:

FHWA has defined an acceptable default tire contact area as a rectangle with an area of $0.01W_L$ (in^2) with a length-to-width ratio of 1:2.5.

$A_{contact} = 0.01\ W_L$ $A_{contact} = 0.01 \times (16{,}000\ lb) = 160\ in^2$

Check dimensions of contact area by confirming that $A_{contact}$ also = 160 in^2

$L = \sqrt{\frac{160}{2.5}} \cdot in$ W = (2.5 x L) L= 8 in W = 20 in

$A_{contact}$ = L X W = 8 in x 20 in = 160 in^2 … checks.

Step #4) Determine the stress exerted per tire in the dynamic load:

$$\sigma_{tire} = \frac{W_{L\text{-}dynamic}}{A_{contact}} \qquad 20{,}800\ lb/160\ in^2 \qquad \sigma_{tire} = 130\ \frac{lb}{in^2}$$

Step # 5) Compare Turfstone strength to H20 or HS20 loading:

Turfstone is manufactured to ASTM C1319 standards requiring a minimum compressive strength of 5,000 psi, which is well in excess of any H20 or HS20 theoretical loading scenarios. As illustrated above, the maximum theoretical tire pressure exerted is 130 psi, so stresses are effectively transferred to the base and subgrade using Turfstone. This significant factor of safety makes Turfstone a viable solution for a flexible grass pavement system.