

## **Gradients with Grasspave<sup>2</sup> and Gravelpave<sup>2</sup>**

Designers often ask what grades, or slopes are appropriate for vehicles when using either our Grasspave<sup>2</sup> or Gravelpave<sup>2</sup> surfaces. The answer will vary depending upon the application, length of gradient, expected weather conditions, weight and speed of the vehicle and particular product.

### **Gentle Gradients**

Most pavements are constructed within a relatively gradual range of gradients ñ from 0% to 6%. If the length of these gradients is less than a couple of hundred feet long (<30 m), which would apply to most drives and parking areas, most people would call these slopes nearly flat. However, if a 5 to 6% slope extends for thousands of feet, or miles on roads, then heavy vehicles require climbing lanes and emergency runaway ramps. Visually, people perceive these gradients as being much steeper, mostly due to the generally steeper slopes these roads are constructed within.

### **Steep Drives and Streets**

The steepest street in San Francisco has a gradient of 21%, and is one block long. Cars use this street constantly and are parked along the curb. The greatest difficulty for cars is traveling uphill and having to stop at the top intersection. City buses do not use this street. Heavy trucks would have great difficulty. Smaller delivery vans are usually successful. Fire trucks are directed to approach from the high side and drive downhill. San Francisco is not subjected to sleet or ice conditions, so traction in wet weather is the only surface concern, which is usually resolved with frequent surface grooves.

### **Golf Carts and Other Light Vehicles**

Golf carts are frequently called upon to traverse short gradients that approach 33% or more ñ on grass or other pavement surfaces. As the length of gradients increase, the slope angle must decrease accordingly, and often determines the make and model of cart path selected for this golf course. Lawn moving equipment manufacturers generally advise against sidehill mowing operations on slopes that exceed 3 to 1 (33%), and sometimes 4 to 1 (25%), depending upon mower design.

### **Firelanes**

Fire Departments will generally establish their own criteria for acceptable gradients for primary (asphalt or concrete streets, drives and parking areas) and secondary (dedicated firelanes to sides and backs of building facilities), especially when alternative surfacing such as grass and gravel are used. Our experience with fire departments from Alaska to Florida has determined that most departments subjected to ice or sleet conditions will accept gradient that do not exceed 6% with firelanes surfaced with Grasspave<sup>2</sup>. A few departments have allowed variance to 8.5% with Grasspave<sup>2</sup> when access was downhill to protect a building ñ, realizing that their heavy vehicles might need towing assistance to get back uphill when continuous downhill access was not available.

### **Traction ñ Grass and Gravel**

The key concern is traction. Generally, Grasspave2 reinforced grass has less traction than gravel filled Gravelpave2. When dry, grass can provide traction for vehicular traffic (golf carts) on slopes above 30%. When wet, gradient upon grass can drop to half of dry gradients, or 15%. Gravelpave2 will maintain vehicular traction to the steeper gradients even in wet conditions.

Guidelines for establishing acceptable gradient criteria in ice conditions are just not possible for any pavement surface. When ice is present, traction decreases dramatically on all pavement surfaces, including grass, gravel, asphalt, and concrete. In these conditions, safety agencies advise against any form of traffic except in extreme emergencies. Of all the surfaces listed above, Gravelpave2 will offer greater traction, for the longest period of time, due to its coarse surface texture. However, even Gravelpave2 surfaces can be completely coated in thick layers of ice.

### **Alternative Surfaces Are Not Always Justified**

Traction on grass and gravel surfaces subject to heavy vehicles can vary also. Load weight, vehicle speed, number of drive axles (or tires), can all influence performance on these surfaces s gradients increase. If the proposed application exceeds the references described above, and the design vehicle cannot be tested on existing grass or gravel surfaces, at the proposed gradient, under weather conditions expected, then the designer must evaluate the impact if the vehicle cannot access the proposed surface.

If safety and security issues related to accessibility override stormwater, aesthetics, or environmental issues, by all means use traditional pavement materials. If a longer drive can be created with a more gradual gradient, then lower environmental costs with the use of alternative grass or gravel surfaces can overcome the use of traditional pavement surfaces, even on a shorter drive.

### **Design Assistance Available**

For any given project application that approaches design criteria that is not easily resolved, please contact the technical support staff at Invisible Structures, Inc. If possible, please provide as much detail as possible, and clarify the issues involved. You can contact us by: phone: 1-800-233-1510; fax: 1-800-233-1522 or email: [sales@invisiblestructures.com](mailto:sales@invisiblestructures.com).