

## Crown and Cross-Slope

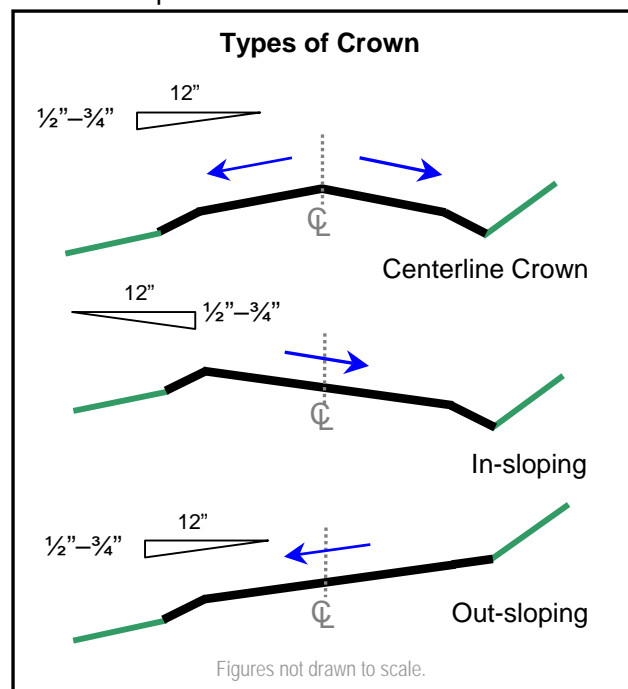
This bulletin illustrates how to drain water from the road surface using three (3) different road surface templates. Crown describes the cross-sectional shape of a road surface. Cross-sloping, either *in*-sloped or *out*-sloped, of the road is the slope angle of the road cross-section, typically measured in percent or expressed as inches of vertical change per foot of horizontal distance.

## The Purpose of Draining the Road Surface

Water allowed to penetrate the road surface, by retention on flat surfaces or infiltration via puddles, weakens both the road surface and road base materials. Water flow on the road allowed to concentrate, such as in wheel tracks, causes erosive damage. The purpose of surface drainage is to cause the water to leave the road as shallow, non-erosive sheet flow in a direction and pattern chosen to suit various combinations of road material, slope, and terrain.

## Types of Road Surface Templates

1. **Centerline crown:** A surface configuration that sheds water to both sides of the road from its longitudinal highpoint (1).
2. **In-sloping:** This surface configuration drains water from the entire width of the road toward the cut-bank or up-slope side. Commonly used on steep side-hills or where speed requires a banked curve, in-sloping can be useful to direct ditch water to better discharge points and also to lessen the probability of vehicles sliding on a steep side-slope.
3. **Out-sloping:** Out-sloped road surfaces drain water from the entire width of the road toward the fill-bank or down-slope side. The road is shaped to avoid collection or concentration of water in a ditch. Minor overland sheet flow is allowed to flow across the road (2). Out-sloping is useful on roads where concerns about winter icing are minimal or side-slopes are gentle.



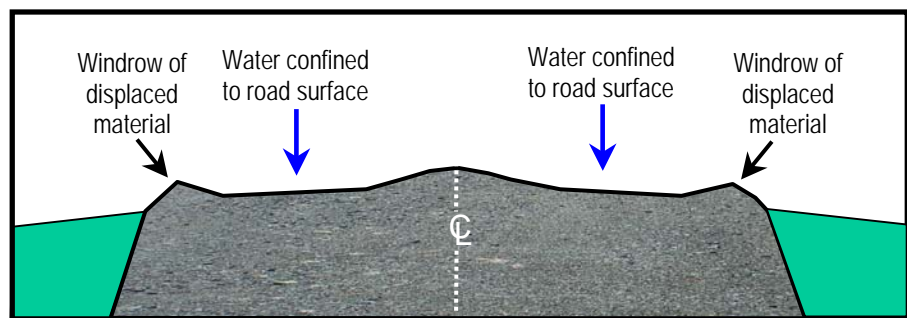
The publishers of this publication gratefully acknowledge the financial support of the Pennsylvania State Conservation Commission. For additional information or assistance, contact: Center for Dirt & Gravel Roads Studies, Penn State University, 207 Research Unit D, University Park, PA 16802 (Toll-Free Phone: 1-866-668-6683, Fax: 814-863-6787, Email: [dirtandgravel@psu.edu](mailto:dirtandgravel@psu.edu)). Additional copies available on our website at: [www.dirtandgravelroads.org](http://www.dirtandgravelroads.org)

## Maintaining Road Crown

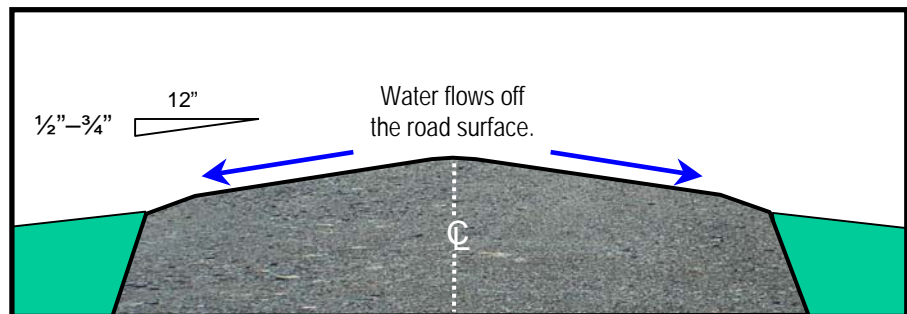
The abrasive and compacting action of traffic, some maintenance activities, and the erosive forces of rain and flowing water wear away at the road surface. Over time, fines, which bind the coarse aggregate together, are lost and the coarse material, displaced by traffic, accumulates along the edge of the road trapping water on the traveled surface. Retained water has additional time to penetrate, saturate, soften, and lubricate the road. Road material in this condition packs more easily, or can be “pushed” to bulge up on the edges changing the shape of the surface cross-section. Additionally, water trapped on the road by the developing windrow of raveled loose stones accumulates velocity, eroding the driving surface in the wheel paths (see Illustration 1). The process starts slowly but if maintenance is not completed on a timely basis, the damage to the road can be severe.

Specific procedures for re-establishing crown during maintenance operations are detailed in the Grading Sequence with a Carbide-Tipped Blade Technical Bulletin.

**Illustration 1.** Centerline crown that has become misshapen over time, road drainage trapped on road by windrow of displaced aggregate. Road drainage is forced to travel on the road surface causing erosion, loss of road material, and increased maintenance. Additional methods of controlling this concentrated flow on the road surface are shown in the Grade Breaks Technical Bulletin.



**Illustration 2.** Centerline crown with proper cross-slope. Road drainage flows without obstruction off the road surface into surrounding vegetation.



## Crown: Paved Roads vs. Unpaved Roads

Unpaved roads must have more crown than paved ones. Pavement is not totally impervious to water but it will shed water more quickly than an unpaved surface. Pavement is typically laid at a cross-slope of 2%, or  $\frac{1}{4}$ " of fall per horizontal foot of road width measured from the centerline toward the ditch.

On unpaved surfaces, the recommended cross-slope is between 4% and 6%, or  $\frac{1}{2}$ " to  $\frac{3}{4}$ " of fall per horizontal foot of width from the centerline toward the ditch. The steeper cross-slope means less potential for water to penetrate and weaken the road and, therefore, longer intervals between maintenance grading operations. The wear and tear of traffic will naturally ‘drive-out’ the crown, so no grading job will last forever! Road shoulders should be slightly steeper. Exercise caution not to grade shoulders significantly steeper on narrow roads where drivers must drive on the shoulder to allow other vehicles to pass (see Illustration 2).

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