# DENALI NATIONAL PARK ROAD DESIGN STANDARDS

1995

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# DENALI NATIONAL PARK ROAD DESIGN STANDARDS

## Section 1.0 INTRODUCTION

These Standards describe the physical conditions which exist for the Park Road when it is at the desired service condition. They are target levels toward which maintenance and repair activities strive. At the same time they are qualitative limits which maintenance and repair activities cannot exceed without management approval and environmental review and compliance. Design standards do not constrain maintenance and repair methods, which are covered under the Road Maintenance Standard Operating Procedures, except to place certain limits on the materials and techniques which may be considered.

These Standards are based upon four interrelated elements:

(1) Retention of the existing character of the road as defined in the 1994 Road System Evaluation, pages 2 and 3.

(2) Long-term protection of the environment through which the road passes, particularly the physical terrain it rests on and influences.

(3) Provision of sufficient stability in the road structure and supportive subgrade to safely handle the traffic type and volume for which the road is designed. This stability will vary seasonally with the variations in subgrade moisture and frost, which will limit the season during which safe structural stability is obtainable.

(4) Road function as a facility that transitions from paved all-purpose roadway at the park entrance to essentially a single-lane gravel roadway beyond the Teklanika River, in keeping with the transition of the visitor experience from frontcountry developed area to backcountry wilderness.

## Section 2.0 RELATED DOCUMENTS

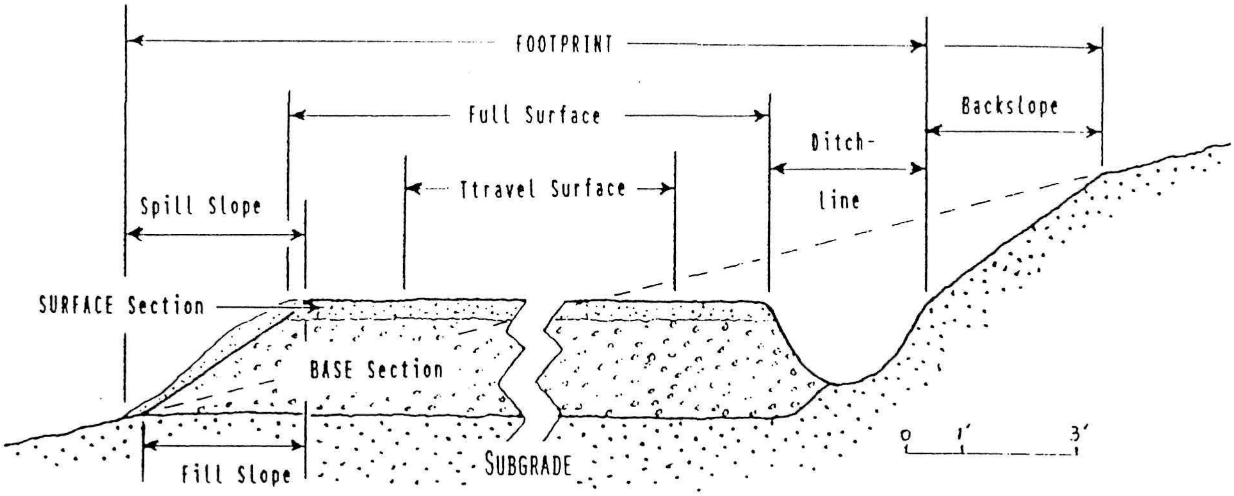
### TECHNICAL

* Denali National Park Road Maintenance Standard Operating Procedures, 1995.
* Denali National Park Design Guide, in draft.
* Denali National Park Road Systems Evaluation, 1994.
* American Association of State Highway and Transportation Officials, A Guide for Design of Pavement Structures, 1993 edition.
* Alaska Department of Transportation Highway Preconstruction Manual, 1992 edition.
* California Department of Transportation Road Design Guide Manual, 1992 edition.
* Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, 1992 edition.
* Standard Specifications for Public Works Construction, 1991 edition.
* Manual of Uniform Traffic Control Devices, 1988 edition.
* National Park Service Sign Manual, 1988 edition.
* National Park Service Park Road Standards, FHWA, 1984 edition.
* USFS Road Design Guide for Secondary Roads, 1980 edition.

### PLANNING

* Denali National Park Environmental Assessment for Road Corridor Development Concept Plan, 1982.
* Denali Park Road Corridor Development Concept Plan, 1983.
* Denali National Park General Management Plan, 1986 edition.
* Denali National Park Gravel Acquisition Plan, 1993 edition.
* Denali National Park Road Systems Evaluation, 1994.

# ROAD CROSS-SECTION DIAGRAMS
## Definitions:




FULL BENCH: The Subgrade cut supporting the road structure is fully excavated into the existing topography, with no Fill sections underlying the road surface other than constructed Base sections.

PARTIAL BENCH: Called "Cut and Fill"; only a portion of the road surface, usually 50% or more, is supported by a Bench cut into the native slope, and the rest is supported by a section of constructed aggregate Fill overlying the native slope. Partial Bench construction tends to structurally overload native slopes.

FILL SLOPE: The segment of the road structure that is Fill rather than Bench-supported Base or Surface material; often refers to the face slope of the Fill section.

SPILL SLOPE: The outer slope created by the overboarding of surface and slide materials during maintenance and repair activities. Spill Slopes are unconsolidated and inherently unstable, and usually cause structural overloading of underlying native slopes and Fill Slopes.

DITCHLINE: The drainage ditch width, measured from the (full) road surface horizontally to the backslope; nominally not less than 1.5 times the ditch depth.

BACKSLOPE: The slope constructed in the native terrain in-slope to the Ditchline to accomodate the road Bench and achieve both native slope stability and design-speed stopping sight distance; usually steeper than the native slope angle of stability.

FOOTPRINT: The imprint of the road structure, measured horizontally. Always extends from the toe of the Fill Slope to the Backslope edge of the Ditchline; if structural stability is at risk, can extend from the toe of the Spill Slope to the upper edge of the Backslope.

FULL SURFACE: The road surface visible to the vehicle driver.

TRAVEL SURFACE: The portion of the Full Surface that is structurally capable of safely holding the Design Vehicle when stopped.

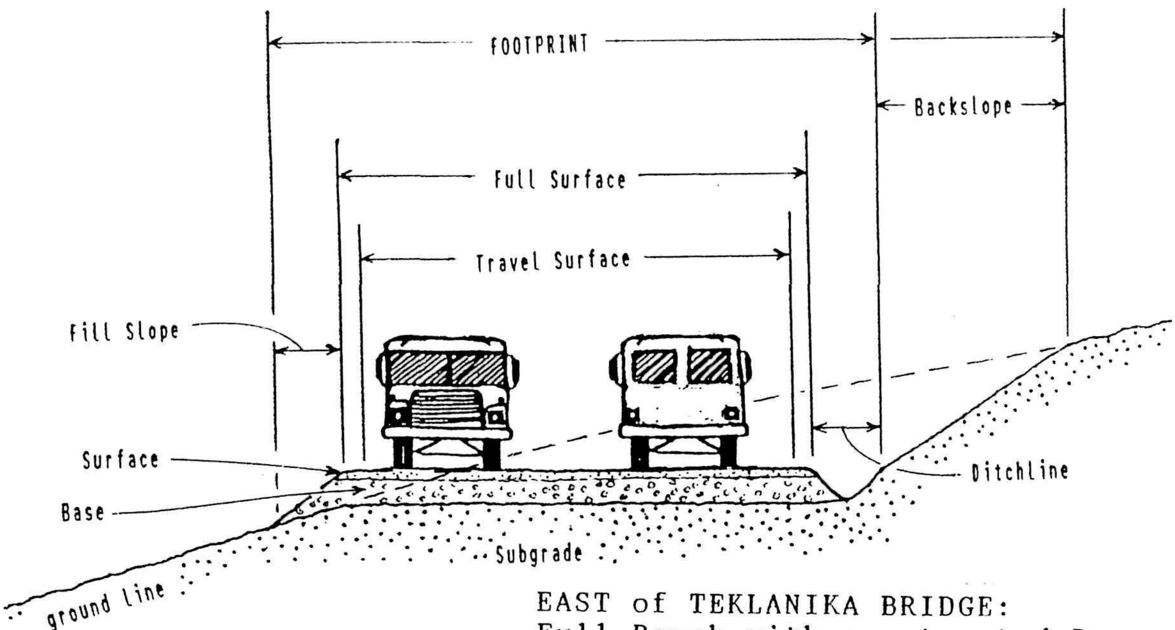
SURFACE SECTION: That portion of the roadway cross-section that consists of Surfacing aggregates. Nominally 4" thick; sections less than 2" thick have no structural value.

BASE SECTION: That portion of the roadway cross-section that consists of constructed coarse Base aggregates, fully compacted to 95% density; sections less than 6" thick have no structural value.

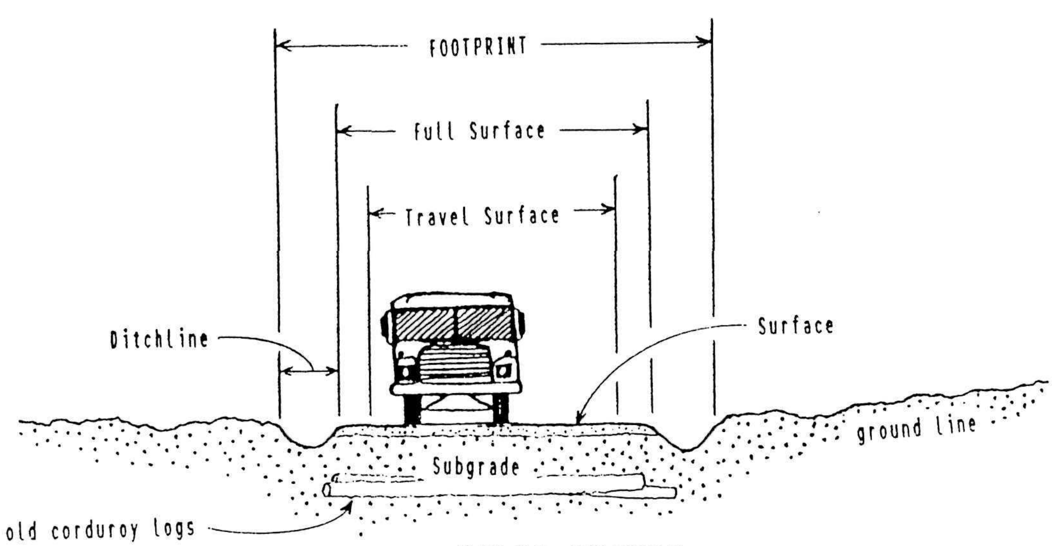
SUBGRADE: Refers to all Subgrade soils, including weathered bedrock (the Park Road has no constructed sub-bases).

GROUNDLINE: The line contour of the native ground in cross-section prior to any road construction disturbance.

EXISTING ROAD CROSS-SECTIONS
Scale 1" = 12'

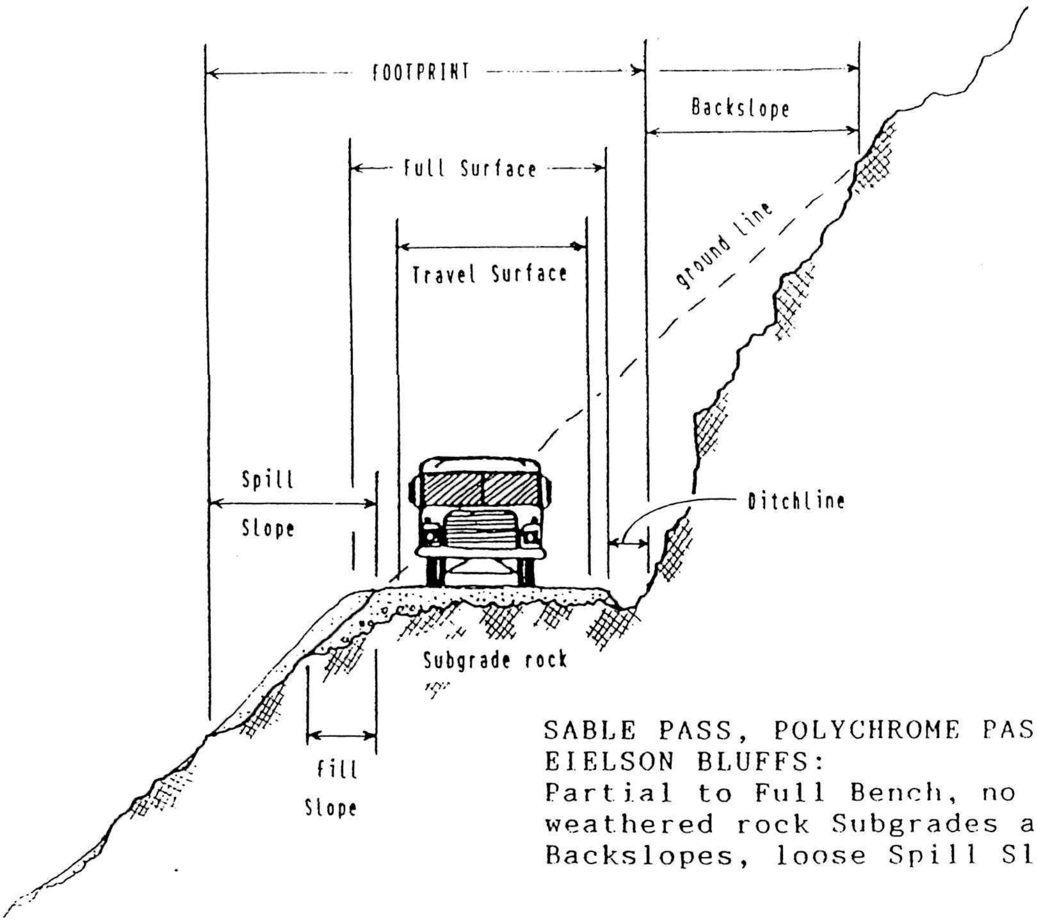



EAST of TEKLANIKA BRIDGE:
Full Bench with constructed Base section, 1.5:1 Backslopes.

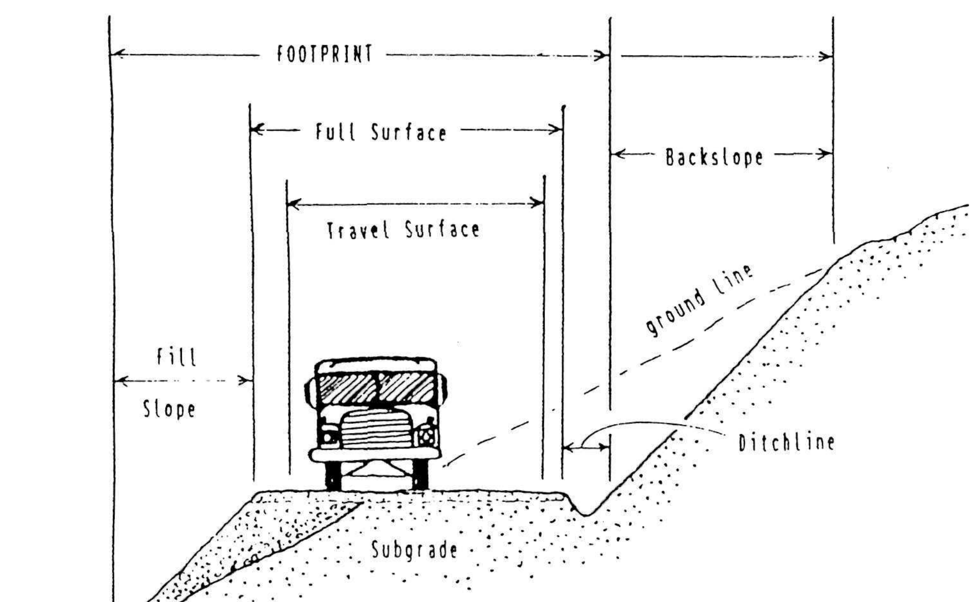



IGLOO FOREST:
Native Subgrade cut, no Base,
old corduroy buried in Subgrade,
drainage allows Subgrade saturation.

EXISTING ROAD CROSS-SECTIONS
Scale 1" = 12'




SABLE PASS, POLYCHROME PASS, EIELSON BLUFFS:
Partial to Full Bench, no Base, weathered rock Subgrades and Backslopes, loose Spill Slopes.




HIGHWAY PASS Area:
Partial Bench and Fill section, no Base, 1:1 Backslopes.

## Section 3.0 ROAD GEOMETRIC STANDARDS

**Section 3.1 Width:** To comply with the existing road character, surface width is variable, conforming to the terrain and existing condition in any particular location, as shown in Table 1. Width shall not exceed the maximums shown, or be less than is safely adequate for the type of traffic allowed on that particular segment (i.e., unrestricted 2 way traffic or controlled passing 2 way traffic).

There is a difference between the full surface width and the travel surface width. The 14.9 miles from the park entrance to the Savage River has constructed shoulders averaging 2 feet wide, which shall be maintained; the travel surface width in this segment is the pavement width. The remainder of the road does not have constructed shoulders. West of the Teklanika River the outer edge of the road surface is structurally unreliable for 2 to 3 feet back from that edge, and the inner (ditchline) edge is structurally unreliable for 1 to 2 feet back from the ditch edge, leaving a safe travel surface 3 to 5 feet narrower than the full visible surface.

The width of the base of the road structural prism (sometimes called the road "footprint") shall be based on the safe structural limits of the prism, reflected in the angle of fill slopes and cut slopes. To the greatest extent possible allowed by the terrain, the road shall be a full bench construction to minimize the width of the road structural prism at its base. In no case should fill slopes be steeper than 1.5 : 1 (34 degrees) or gentler than 2.5 : 1 (22 degrees), and fill slope materials shall be selected to conform to those limits.

**TABLE 1**
**ROAD SURFACE WIDTH**

| ROAD SEGMENT | EXISTING SURFACE WIDTH IN 1994 | FULL SURFACE WIDTH | TRAVEL SURFACE WIDTH |
|---|---|---|---|
| Entrance to Savage River | 24' to 28' | 24' to 28' | 22' to 24' |
| Savage River to Teklanika River | 28' to 38' | 28' | 24' |
| Teklanika River to Tatler Creek | 19' to 24' | 20' to 22' | 17' to 19' |
| Tatler Creek to East Fork of the Toklat | 14' to 26' | 17' to 24' | 12' to 20' |
| East Fork to Toklat River | 15' to 25' | 15' to 23' | 12' to 20' |
| Toklat River to Eielson V.C. | 18' to 26' | 18' to 24' | 14' to 20' |
| Eielson V.C. to Grassy Pass | 13' to 21' | 15' to 20' | 12' to 16' |
| Grassy Pass to North Boundary | 14' to 22' | 16' to 21' | 12' to 16' |
| North Boundary to Kantishna | 15' to 18' | 15' | 12' to 13' |

**Section 3.2 Alignment:** To comply with existing road character, both horizontal and vertical alignments shall be maintained as presently existing. Abrupt changes in vertical alignment resulting from periodic and/or continuing sub-grade deformation shall be repaired following a parabolic arc which retains a smooth grade transition throughout the replaced section.

Where slope failures necessitate horizontal realignment in order to retain the road (i.e. realignment is the only effective alternative) such realignment shall conform to the site topography and maintain the sinuous character of the road. Realignments and changes to road width shall be considered projects requiring environmental review and compliance, not routine repairs.

The vertical alignment shall, by its constraint of stopping sight distance, determine the maximum vehicle speed on the particular road segment. The horizontal alignment shall by its constraint on safe turning radius, determine the maximum design vehicle wheelbase and overall length permissible on that particular road segment.

**Section 3.3 Design Speed:** Established by the road alignment (stopping sight distance) and surface friction characteristics, the maximum design speed (and the existing posted speed limit) is 35 miles per hour on both the paved and gravel sections of the road to the Teklanika River, and 30 miles per hour west of the Teklanika River.

Maximum design speed set by the stopping sight distance for particular road sections is shown by Table 2. All maximum design speeds assume a dry and properly maintained road surface providing good friction characteristics. Excessive soil moisture, loss of aggregate or aggregate filler, rain and other factors will make maximum safe speed considerably less than the design speed.

**TABLE 2**
**MAXIMUM DESIGN SPEED BY SIGHT DISTANCE**

| EAST OF TEKLANIKA RIVER | | | | | | |
|---|---|---|---|---|---|---|
| SIGHT DISTANCE TO THE NEXT CREST OR CURVE | | | | | | |
| | Under 80 ' | 80 to 125' | 126 to 150' | 151 to 200' | 201 to 225' | 226 to 275' |
| M P H = | 10 | 15 | 20 | 25 | 30 | 35 |
| | | | | | | |
| WEST OF TEKLANIKA RIVER | | | | | | |
| SIGHT DISTANCE TO NEXT CREST OR CURVE | | | | | | |
| | Under 175' | 176 to 250' | 251 to 325' | 326 to 400' | Over 400' | |
| M P H = | 10 | 15 | 20 | 25 | 30 | |

Any alteration of existing slopes or bluffs to achieve minimum stopping sight distance shall be treated as a project requiring prior environmental and management review and approval. Minimum Sign Sight Distance shall be 350 feet east of the Teklanika River, and 300 feet west of the Teklanika River.

**Section 3.4 Grade:** The longitudinal grades of the road shall be maintained as existing (see Table 3), including grades resulting from repairs as discussed under Vertical Alignment (Section 3.2). Maintenance and repair activities shall result in grade changes being made over the linear distances shown in Table 4 to control traffic induced road damage.

**TABLE 3**
**EXISTING / MAXIMUM ROAD GRADES**

| ROAD SEGMENT | GRADE RANGE | |
|---|---|---|
| Entrance to the Savage River | 0.5 to 11% | av. 3 % |
| Savage River to Teklanika River | 0.5 % to 9 % | av. 2.7 % |
| Teklanika River to Tattler Creek | 0.5 % to 7 % | av. 2 % |
| Tattler Creek to East Fork | 1 % to 13 % | av. 4.9 % |
| East Fork to Toklat River | 0.5 % to 16 % | av. 3.3 % |
| Toklat River to Eielson V.C. | 5 % to 15 % | av. 4 % |
| Eielson V.C. to Grassy Pass | 0.5 % to 12 % | av. 3.9 % |
| Grassy Pass to the North Boundary * | 1 % to 12 % | av. 2.2 % |
| North Boundary to Kantishna | 0.5 % to 13 % | av. 3 % |

* Includes Wonder Lake Campground Road.

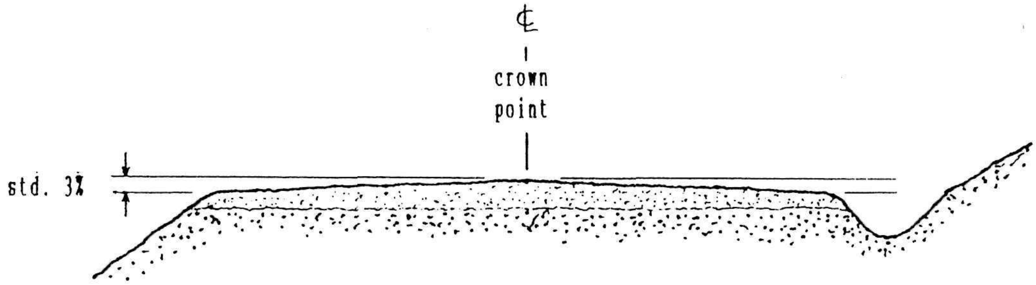
Maximum allowable grades are a function of the road surface material (cohesion and friction characteristics), the torque load induced by the vehicle tires on that material, and the length of grade section. Grades shall not exceed the upper limits of the grade ranges shown in Table 3.

**TABLE 4**
**GRADE TRANSITION DISTANCE**

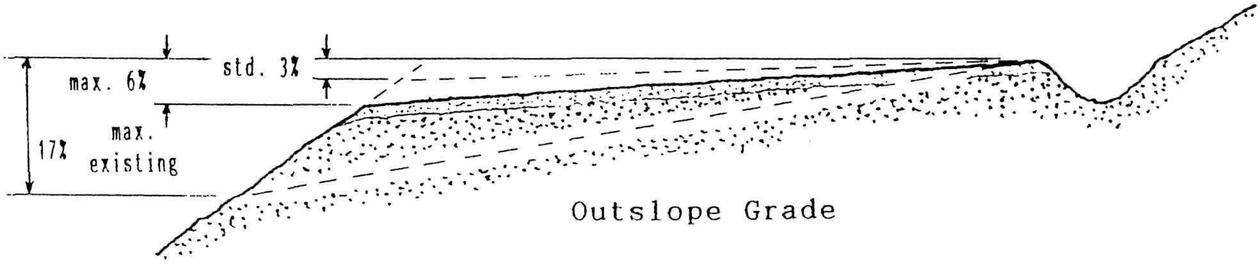
| DESIGN SPEED IN M P H | GRADE CHANGES IN PERCENT | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 5 | 7 | 10 | 12 | 15 |
| 10 | 10' | 25' | 35' | 50' | 60' | 75' |
| 15 | 15' | 40' | 55' | 80' | 95' | 120' |
| 20 | 20' | 50' | 70' | 100' | 120' | 150' |
| 25 | 40' | 100' | 140' | 200' | 240' | 300' |
| 30 | 60' | 150' | 210' | 300' | 360' | 450' |
| 35 | 80' | 200' | 280' | 400' | 480' | 560' |

Grade in Cross - Section (i.e., grade across the width of the surface) shall be either flat, gently outsloped (3% to 6%), or lightly crowned (3%) as required for surface drainage on the particular section. Superelevations in horizontal curves are discouraged, and in no case shall exceed 6%.

GRADE IN CROSS-SECTION
Scale 1" = 5'




Crown




Outslope Grade

**Section 3.5 Clearance:** Vegetation shall be controlled to maintain the stopping sight distance established by road alignment and design speed (Table 2), the sign sight distance, to preclude physical contact by vegetation with any vehicle properly using the road and prevent damage to the road structure and/or impedance of drainage. Standard clearance widths and height assume a maximum 3-year cycle of vegetation control (i.e. each section of road receives control work at least once every 3 years), and that revegetation growth rates are slow enough that clearance is not compromised in less than 3 years. Where growth rates dictate, the control cycle will be shortened if feasible, rather than enlarging the clearance limits.

Vegetation shall be controlled to provide a cleared travelway the height of the maximum design vehicle plus 5 feet, and the full width of the road surface plus 6 horizontal feet each side (or ditch width plus 3 horizontal feet where a ditchline exists). Nominal mowing height shall range from 4 inches above ground at the inner margin to 8 inches above the ground at the outer margin. Vegetation which impedes ditch function or annual maintenance of constructed shoulders and fill slopes required for structural stability, or which causes physical disruption of the structural section, road surface or impedance of drainage will be removed.

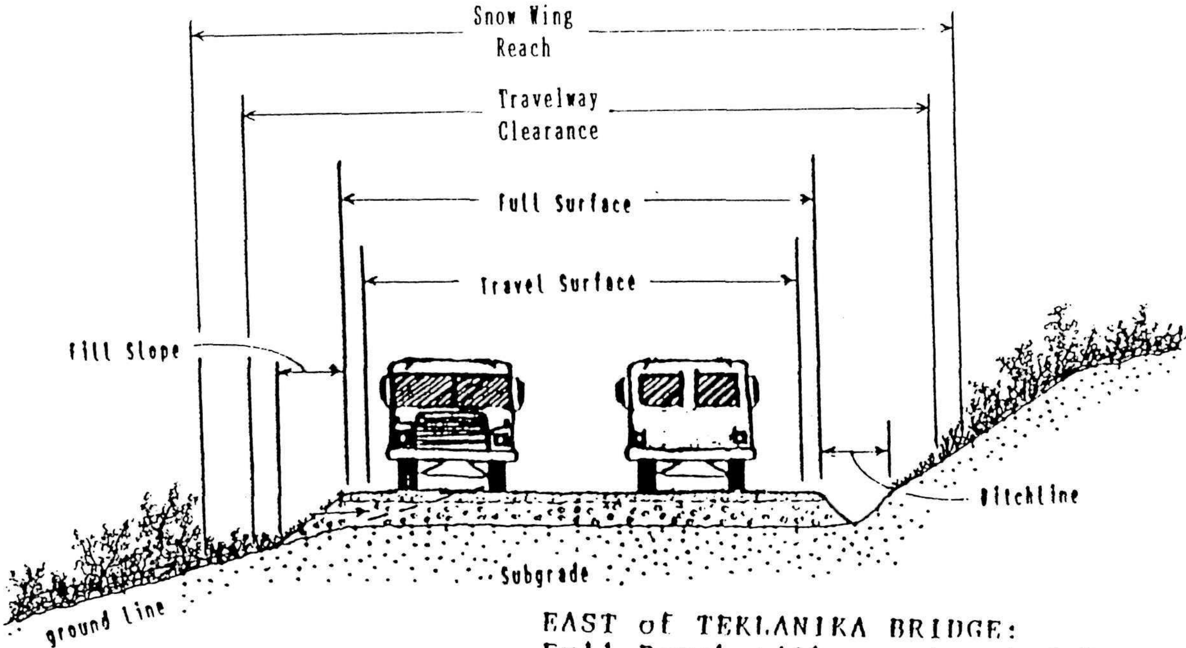
In order to minimize the constructed appearance of the cleared travelway, trees (primarily spruce) 6 inches or more in diameter (when measured at 1 foot above ground level), shall be left if at all possible. Cutting widths shall be randomly varied up to 1/3 of the width of the cleared margin as necessary to prevent the appearance of a manicured or straight cut-line. Cutting season and methods will be selected to minimize the duration of the "freshly cut" appearance of the work.

Large deciduous vegetation which grows within the normal zone of spring snow removal activities is subject to severe damage from both snow crushing and equipment blades. Deciduous vegetation having a stem diameter of 3/4 inch or more when measured at 1 foot above ground level, and which is or will be broken, crushed, uprooted or extensively scarred by snow removal activities, should be removed by cutting in order to preserve roadside esthetics and reduce annual machine damage. While this damage can occur beyond the reach of a grader-mount snow wing, snow wing reach defines a reasonable maximum zone in which the selective control of large vegetation may occur (see Table 5).

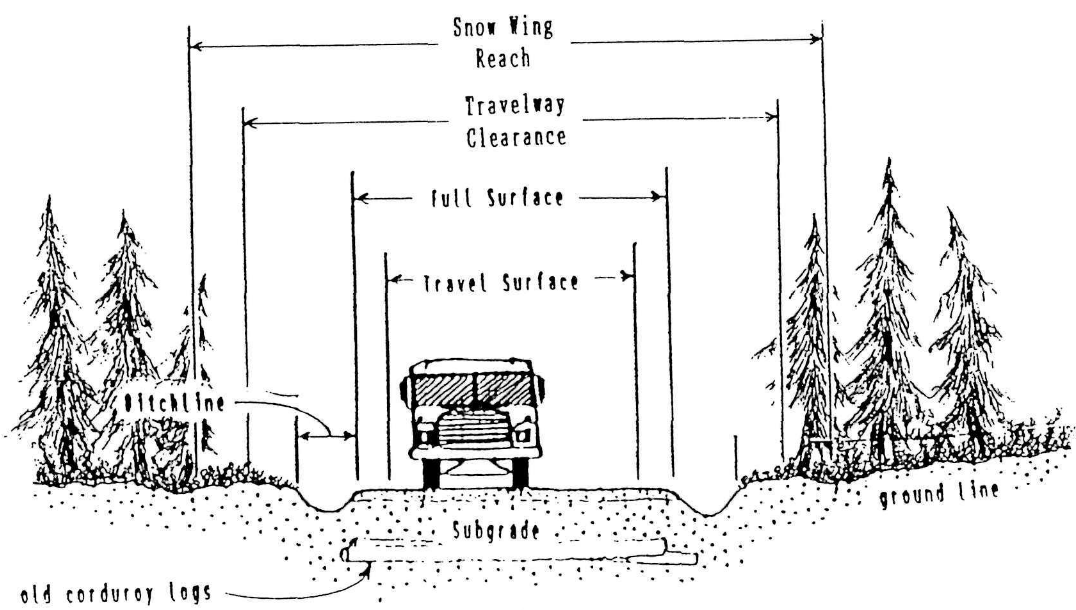
**TABLE 5**
**SNOW WING HORIZONTAL CLEARANCE BY SLOPE ANGLE**

| Slope % | 0 to 45% | 45 to 70% | 70 to 100% | 100 to 130% | Over 130% |
|---|---|---|---|---|---|
| Clearance | 10' | 9' | 8' | 7' | 6' |

CLEARANCE LIMITS
Scale 1" = 12'

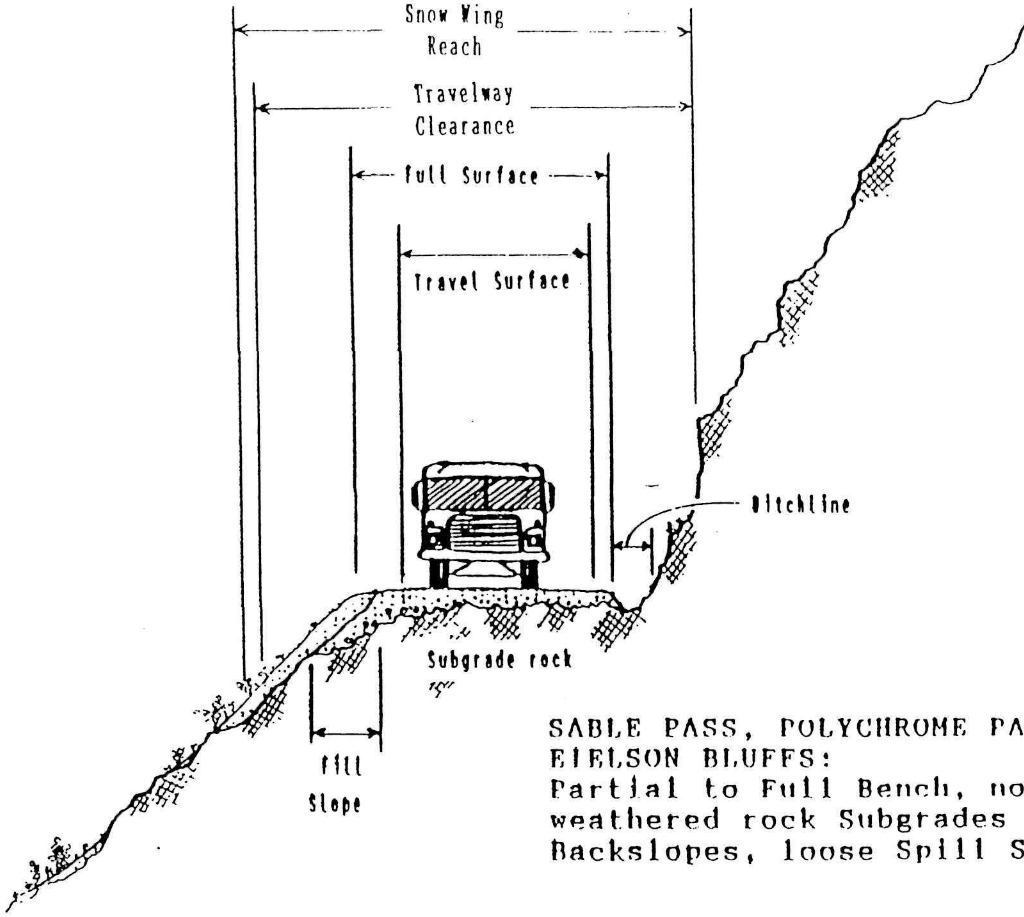



EAST of TEKLANIKA BRIDGE:
Full Bench with constructed Base section, 1.5:1 Backslopes.

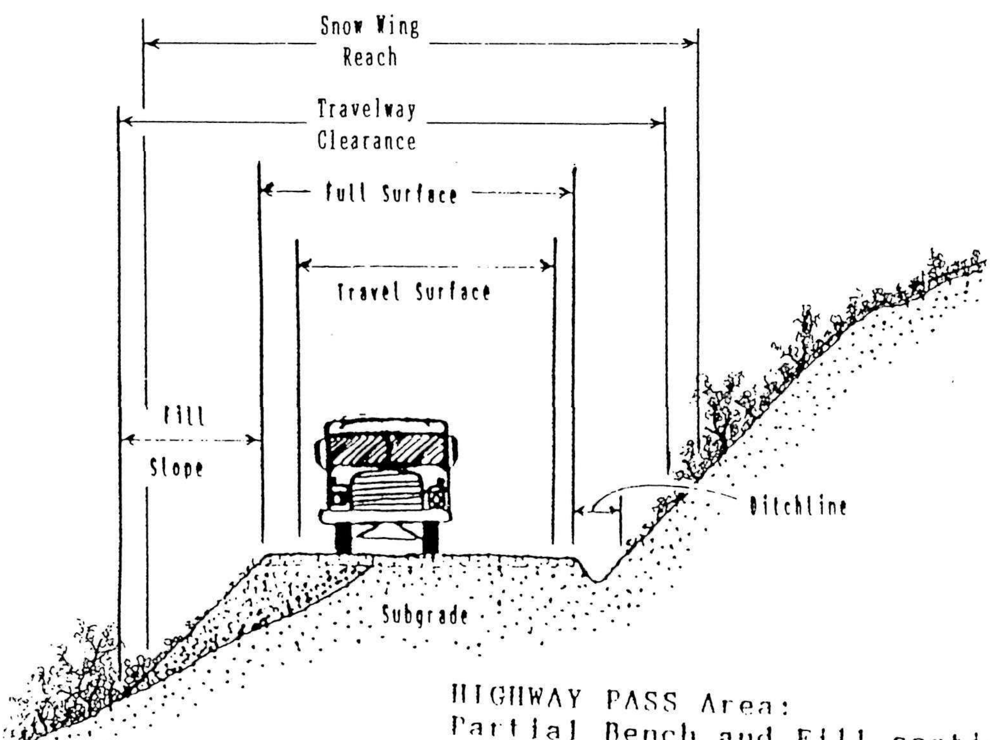



IGLOO FOREST:
Native Subgrade cut, no Base,
old cordutoy buried in Subgrade,
drainage allows Subgrade saturation.

CLEARANCE LIMITS
Scale 1" = 12'




SABLE PASS, POLYCHROME PASS,
EIELSON BLUFFS:
Partial to Full Bench, no Base,
weathered rock Subgrades and
Backslopes, loose Spill Slopes.




HIGHWAY PASS Area:
Partial Bench and Fill section, no
Base, 1:1 Backslopes.

**Section 3.6 Drainage:** Drainage is a function primarily of site topography and soils. As such it shall be adequate to manage water flow type and volumes affecting the road prism, including within the subgrade section of the road prism, without adversely affecting the road or the adjacent terrain. Drainage system design will accommodate and mimic adjacent natural drainage patterns to the greatest extent feasible without sacrificing road stability.

Drainage systems shall be installed and maintained so as to not alter standard road width. Ditch design shall follow the general rule of width equals at least 2.5 times the depth, and ditch banks are not steeper than a 1.5 to 1 slope. Cross culverts shall be sized and located to handle maximum water volumes for the particular location.

Surface drainage culverts shall be extended from the inner edge of the ditch bottom to daylight in the downslope below the road, shall be downsloped not less than 4% or more than 8%, and shall be placed at the angle to the ditchline axis that allows for water diversion from the ditch without siltation or ponding at the culvert inlet. Catch basins at culvert inlets shall have a radius of at least 2 times the culvert diameter to allow for effective change in direction of water flow from the ditch to the culvert. Culvert outlet channels may be hardened with emplaced rock, buried gabions or geoblocks if necessary to prevent slope scarring or destabalizing erosion from normal culvert flows.

Bridge and/or culvert crossings of streams shall be designed, installed and maintained to preserve natural flow regimes, physical and biological stream characteristics, and the free passage of native fish. In particular, the sizing, configuration and placement of in - stream culverts will ensure the preservation of suitable hydraulic conditions to allow normal fish passage to continue unimpeded.

Subsurface drains shall be site specific in design to provide for enhancing the structural stability of the road section without reducing the structural stability of the adjacent natural slopes. They may include deep pipe drains, French drains, curtain drains and permeable section drains, as necessary to match the soils hydrology and mechanics of the particular location. For clarification of drainage system component design, refer to the Denali National Park Road Design Guide.

**Section 3.7 Parking Areas, Pullouts and Pulloffs:** Parking areas, defined as areas which vehicles can pull into and park completely off the road travel surface, shall conform to existing configuration and size. Pullouts, defined as widened shoulder sections onto which a bus can pull and be completely off the road travel surface, shall conform to existing configuration and size and by definition be not less than 10 feet or more than 12 feet wide. Passing Pulloffs, defined as widened road surface sections in one lane roadway which allow for safe bus passing with one bus stopped, shall conform to existing configuration and size and by definition have a total travel surface width of not less than 20 feet. The surfaces of all parking areas, pullouts and passing pulloffs shall have at least the same stopped vehicle structural load capacity as the adjacent roadway.

The standard minimum functional length of any parking area, pullout or pulloff shall be its existing length. Any pullout or pulloff used routinely by buses must be at least 60 feet long to be considered safe for such use. The enlargement, relocation or addition of any parking area, pullout or passing pulloff shall be considered a project requiring environmental review and compliance.

**Section 3.8 Bridges:** Bridges shall conform to the minimum load bearing capacities required by the heaviest vehicle allowed on the road (nominally 90,000 pound crawler dozers and 150,000 pound GVW tractor trailers). Bridge capacity and condition is determined by inspection every 2 years by FHWA bridge engineers. Bridge replacements shall conform to existing in type, surface width and function unless structural safety requirements cannot thereby be met. At the time any bridge needs replacement, esthetic treatments to produce a more rustic appearance shall be explored.

**Section 3.9 Signing and Marking:** The goal of signing and marking of the park road is to provide appropriate traffic control, safety and information in a timely manner. The Manual of Uniform Traffic Control Devices (MUTCD), as supplemented by the National Park Service Sign Manual, contains details regarding design, location and application of road signs and markings as they apply to park roads. As such they shall supply primary guidance for signing and marking standards. In addition the signs and markers shall be installed in a manner which blends and compliments local terrain characteristics to the greatest practical extent.

Pavement marking shall also comply with the MUTCD standards. Number and location of signs and markers shall be as required for traffic safety and guidance based on the existence of a cadre of trained bus drivers.

Traffic control and informational signs shall be installed at 5 feet above the height of the road surface and 5 feet beyond the road edge as per MUTCD requirements. The sign backs and posts shall be painted brown as per NPS Sign Standards requirements. Metal sign posts shall be breakaway design. Markers (such as mile markers) shall be of the Carsonite type or equal, shall be brown in color and installed per NPS Sign Standards requirements for markers and delineators. Construction and temporary signing shall meet all applicable safety requirements, with the exclusion of painting sign backs and posts, and breakaway post design.

## Section 4.0 STRUCTURAL DESIGN STANDARDS

Road structural standards shall reflect the minimum load capacities shown in the following table. Subgrade soil design capacity shall assume 30% of saturation in moisture content, and a structural capacity in the outermost 3 feet of the road surface west of Savage River equal to at least 80% of the centerline capacity, achieved by means which will not alter the road character.

**Section 4.1 Definition of Structure:** The road structure is defined as the load bearing road section, consisting of the surface, the constructed base (if any), and the subgrade soils, and including the downslope whether it is natural terrain or a fill slope. Additionally, the constructed backslope is a structural element which, while not load bearing, must account for the structural stability of the ground in which it is cut.

Standards for the physical road structure provide for safely adequate load carrying capacities and slope stability while retaining the existing road character. Structural standards determine the Design Vehicle and repetitive loading characteristics of the road, which is the reverse of the normal design process. Structural standards assume the normal ground conditions encountered within a summer operating season of approximately 110 days, and do not attempt to overcome the seasonal subgrade weakening caused by spring runoff saturation and frost activity.

For structural design purposes, the road is viewed in 4 distinct categories:

1. Road has constructed base and surface aggregate sections, and an asphalt pavement (Park Entrance to Savage River).

2. Road has a predominately constructed base and surface aggregate sections (Savage River to Teklanika River).

3. Road consists of a constructed surface aggregate section on native subgrade soils which are relatively stable (generally Teklanika River to Grassy Pass, although sections of Category 4 road exist within this segment).

4. Road consists of a constructed or applied surface aggregate section on native subgrade soils which are unstable (generally Grassy Pass to Kantishna, although sections of Category 3 road exist within this segment).

The predominance of narrow Category 4 road west of Eielson Visitor Center requires that the Design Vehicle for that section of road be different than the Design Vehicle for the rest of the road.

**Section 4.2 Design Vehicle:** For the use in structural standards, the Design Vehicle is the predominant heavy vehicle using the road, not the heaviest vehicle which may travel the road.

| | |
|---|---|
| East of Eielson Visitor Center: | Bus, H15 loading, max. GVW 36,200 pounds, axle weight ratio .365 front / .635 rear, max. length 40 feet. |
| West of Eielson Visitor Center: | Bus, H15 loading, max. GVW 26,000 pounds, axle weight ratio .294 front / .706 rear, max. length 36 feet. |

**Section 4.3 Design Load:** For the purposes of Design clarity, normal tire inflation is assumed. Compression, shear and surface torque loading are based on the Design Vehicle Gross Vehicle Weight (GVW) and axle ratings, as follows:

**TABLE 6:**
**DESIGN VEHICLE LOADING**
East of mile 66.0: Bus EAL* = 4.38

| | FRONT AXLE = | REAR AXLE = |
|---|---|---|
| STATIC WHEEL LOAD ** | 6.6 K | 5.8 K |
| INFLATED TIRE PRINT + | 7.3" x 12.1" = 88 si | 7.5" x 11.0" = 82 si |
| WHEEL BEARING LOAD, IN PSI | 75 PSI | 71 PSI |

**Notes:** * EAL = Equivalent Axle Load, based on standard 12 K axle.
** Assumes H15 loading, dual wheels on rear axle.
+ From measured tire prints of 24 buses at Savage Check Station, 1994; median print used for tables.
K = KIP Axle Load Value

**TABLE 7:**
**DESIGN VEHICLE LOADING**
West of mile 66.0    Bus EAL = 1.24

| | FRONT AXLE = | REAR AXLE = |
|---|---|---|
| STATIC WHEEL LOAD | 3.8 K | 4.6 K |
| INFLATED TIRE PRINT + | 7.0 x 10.6 = 74 si | 7.0 x 10.6 = 74 si |
| WHEEL BEARING LOAD, IN PSI | 51 PSI | 62 PSI |

Traffic volume (repetitive) loading is based on Denali GMP maximum limits for buses (as modified in 1994, increasing buses to 5483 and reducing private vehicles to 3275), and projected volume of Natural History Tour buses, and full size (20 ft. +) RV's, assuming a normal structural service life of 20 years. Traffic that is not limited by the GMP is estimated. Volume loading for design standards is derived as follows:

**TABLE 8:**
**ANNUAL VEHICLE REPETITIVE LOADING**

| | 1994 | 2014 * | x 2 = Annual Traffic | Annual Traffic in EAL |
|---|---|---|---|---|
| A. Eielson buses, from GMP # | 4498 | 4483 | 8966 | 39271 |
| B. Wonder Lake buses, from GMP # | 985 | 1000 | 2000 | 2480 |
| C. NHT buses, to 17.0 mile | 1000 | 2000 | 4000 | 17520 |
| D. Private RV's, to 15.0 mile + | 3500 | 6000 | 12000 | 516 |

Note on Table 8:    2 lane road Mile 0.0 to Mile 31.0, single lane road west of Mile 31.0

Volume Loading for Structural Standard is as follows:

**TABLE 9:**
**ANNUAL VOLUME LOADING OF THE STRUCTURE**

| | total EAL | per lane | total TI ** | per lane |
|---|---|---|---|---|
| 0.0 to 15.0 mile A+B+C+D= | 59787 | 28894 | 6.5 | 6 |
| 15.0 to 31.0 mile A+B+C = | 59271 | 29636 | 6.5 | 6 |
| 31.0 to 66.0 mile A+B= | 41751 | 41751 | 6 | 6 |
| 66.0 to 88.0 mile B = | 2480 | 2480 | 4.5 | 4.5 |

Notes: * = Projected traffic at 20 years.
** TI = Traffic Index, a numerical representation of repetitive wear over time; see Denali Road Design Guide for application.
+ Assumed average EAL of 0.65.
# As modified in 1994

**TABLE 10:**
**DESIGN STANDARD STRUCTURAL LOAD LIMITS**

| | BEARING (COMPRESSION) | TRAFFIC INDEX |
|---|---|---|
| 0.0 to 31.0 mile | 75 PSI | 6.5 |
| 31.0 to 66.0 mile | 75 PSI | 6 |
| 66.0 to 88.0 mile | 62 PSI | 4.5 |

**Section 4.4 Load-Bearing Section:** The cumulative capacity of subgrade soils, base section (if used) and surface section must equal the Design Load during the bus operating season. During the bus operating season, in areas where the cumulative capacity of the road structure fails to equal the Design Load placed on that particular section, repairs shall be made until adequate structural load bearing capacity is achieved. Downslopes, in particular fill slopes, shall be considered part of the load bearing structure. When factors such as spring thaw and saturation render the standard impossible to achieve, traffic shall be restricted as necessary for safety and to achieve road stability.

The bearing and shear capacity of weak subgrade soils may be strengthened through use of geotextiles or geowebs, and/or interdiction and diversion of subsurface and surface infiltration water. The thickness of constructed base and surface sections may be minimized where feasible through the use of geotextiles, geowebs, or other appropriate bridging membranes, and/or applications of aggregate fillers, palliatives and binders.

It is noted that obtaining the maximum cohesion capacities on untreated gravel and native soil surfaces may not be possible. Since substandard cohesion capacity contributes directly to accelerated washboarding, potholing and gravel loss, efforts shall be made to achieve 100% capacity by means which will not alter the road character, including use of binders and modification of tire pressures.

The use of exposed slope retaining structures which alter existing road character (i.e. earthwall, binwall, cribwall, sheetpiling, etc.) is generally precluded by this standard. However, instances may arise where the use of such a structure may be necessary for traffic safety and/or prevention of damage to the road structure or adjacent resources. Such instances shall be treated as projects requiring management approval, full environmental review and compliance, with site specific design.

**Section 4.5 Backslopes:** Backslopes (i.e. cut slopes) are not load bearing, but are structural in their need to achieve stability relative to normal gravity and lubrication influences. Existing backslopes which are not failing shall be considered stable. Where backslope failure occurs, or where natural slope failure into the road requires establishment of a backslope, the backslope angle shall be based on the inherent shear angle for the particular soil under normal spring runoff moisture loading. In no case shall the newly constructed backslope extend horizontally from the ditchline more than 2 times the width of the roadway; where the angle of stability indicates a wider footprint will be necessary, the backslope shall be cut to meet the natural slope line at the 2 -times-roadway width margin, and if safely possible slope stability will be allowed to occur through natural gravitational failure over time.

Efforts to stabilize downslopes and backslopes through revegetation and use of geotextiles or fiber mats shall be encouraged. The Division of Resources Management shall prepare site specific revegetation plans for such efforts and shall guide and support them on the ground.

**Section 4.6 Drainage:** While surface and subsurface drainage directly influences the structural capacity and stability of both load-bearing sections and their adjacent natural or constructed slopes, it also directly influences road geometry. Therefore both the structural and geometric standards are discussed in Section 3.6.