

ACRONYMS COMMON TO CDOT

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
ABC	Aggregate Base Course
ACI	American Concrete Institute
ACPA	American Concrete Pavement Association
ADT	Average Daily Traffic
AMC	Annual Maintenance Cost
ARA	Asphalt Rejuvenating Agent
ASR	Alkali Silica Reactivity
CAPA	Colorado Asphalt Pavement Association
CBR	California Bearing Ratio
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
CIR	Cold In-Place Recycling
CP	Colorado Procedure
CTB	Cement Treated Base
CPPP	Concrete and Physical Properties Program
DARWin™	Design Analysis and Rehabilitation Program for Windows
DTD	Division of Transportation Development
EATB	Emulsified Asphalt Treated Base
ESAL	Equivalent Single Axle Load

FASB	Foamed Asphalt Stabilized Base
FDR	Full Depth Reclamation
FHWA	Federal Highway Administration
FIR	Field Inspection Review
FOR	Final Office Review
FMM	Field Materials Manual
FWD	Falling Weight Deflectometer
HBP	Hot Bituminous Pavement
HIR	Hot In-Place Recycling
HMA	Hot Mix Asphalt
HMAP	Hot Mix Asphalt Pavement
IRI	International Roughness Index
JPCP	Jointed Plain Concrete Pavement
LCCA	Life Cycle Cost Analysis
LL	Liquid Limit
LS	Loss of Support
LTB	Lime Treated Base
LTPP	Long Term Pavement Performance
MMS	Maintenance Management System
MGPEC	Metropolitan Government Pavement Engineering Council
M_r	Resilient Modulus
MR	Modulus of Rupture
MUTCD	Manual on Uniform Traffic Control Devices

NMAS	Nominal Maximum Aggregate Size
N _{DES}	Recommended SuperPave™ Gyratory Design Revolution
NDT	Nondestructive Testing
NLPM	Network Level Pavement Manager
PCCP	Portland Cement Concrete Pavement
PDM	Pavement Design Manual
PG	Performance Grade
PI	Plasticity Index
PJR	Pavement Justification Report
PMBB	Plant Mix Bituminous Base
PMBP	Plant Mix Bituminous Pavement
PDPM	Pavement Design Program Manager
PM	Pavement Manager
PMS	Pavement Management System
PMSC	Plant Mix Seal Coat
PTSC	Pavement Type Selection Committee
PSI	Present Serviceability Index
PWF	Present Worth Factor
RAP	Reclaimed Asphalt Pavement
RCP	Reclaimed Concrete Pavement
RCC	Roller Compacted Concrete
RIC	Research Implementation Council
RME	Region Materials Engineer

RSL	Remaining Service Life
SHRP	Strategic Highway Research Program
SMA	Stone Matrix Asphalt
SN	Structural Number
TCP	Traffic Control Plan
VFA	Voids Filled with Asphalt
VMA	Voids in the Mineral Aggregate
WIMS	Weigh-In-Motion Station
WSN	Weighted Structural Number
WWF	Welded Wire Fabric

DESIGN OF PAVEMENT STRUCTURES DEFINITIONS

ADT (Current Year)

The average two-way daily traffic (ADT), in the number of vehicles, for the current year. The average 24-hour volume, being the total number during a stated period, divided by the number of days in that period. Unless otherwise stated, the period is a year.

ADT (Design Year)

The average two-way daily traffic for the future year used as a target in design.

AADT

The annual average two-way daily traffic volume. It represents the total traffic on a section of roadway for the year, divided by 365. It includes both weekday and weekend traffic volumes.

Analysis Period

The period of time for which the economic analysis is to be made. Ordinarily, the period will include at least one rehabilitation activity.

Approach Slab

Section of pavement just prior to joint, crack, or other significant roadway feature relative to the direction of traffic.

Arterial Highway

A highway primarily for through traffic, usually on a continuous route.

Asphalt Mix Design

The process and documentation of proportions of asphalt, cement, and mineral aggregate with the percentages of each component and size of particle that will result in a homogeneous mix and can be compacted into asphaltic concrete.

Asphalt Rejuvenating Agent (ARA)

A bituminous emulsion sprayed on new asphalt pavements to seal them from the adverse environmental effect of air and water. ARA is also used on dry, weathered asphalt pavement to give them new vitality and plasticity.

Asphalt Overlay

One or more courses of asphalt construction on an existing pavement. The overlay may include a leveling course, to correct the contour of the old pavement, followed by uniform course or courses to provide needed thickness.

At-Grade Intersection

An intersection where all roadways join or cross at the same level.

Axle Load

The total load transmitted by all wheels on a single axle extending across the full width of the vehicle. Tandem axles 40 inches or less apart will be considered as a single axle.

Base Course

The layer or layers of specified or selected material of designed thickness placed on a subbase or subgrade to support a surface course.

Bituminous

A term used to designate materials that are derived from petroleum, coal, tar, etc.

Bituminous Surface Treatment

Alternate layers of bituminous binder material and stone chips.

Binder

Asphalt cement used to hold stones together for paving.

Bleeding

A type of asphalt pavement distress identified by a film of bituminous material on the pavement surface that creates a shiny, glass-like, reflective surface that may be tacky to the touch in warm weather.

Block Cracking

The occurrence of cracks that divide the asphalt surface into approximately rectangular pieces, typically one square foot or more in size.

Blowup

The result of localized upward movement or shattering of a slab along a transverse joint or crack.

California Bearing Ratio (CBR) Test

An empirical measure of bearing capacity used for evaluation of bases, subbases, and subgrades for pavement thickness design.

Cement Treated Base

A base consisting of a mixture of either mineral aggregate or granular soil and portland cement mixed, and spread on a prepared subgrade to support a surface course.

Centerline

The painted line separating opposing traffic lanes.

Channels

A ditch or canal adjacent to the roadway.

Chipping

Breaking or cutting off small pieces from the surface.

Chip Seal

A seal coat consisting of the application of asphalt followed by a cover aggregate.

Cohesive Failure

The loss of a material's ability to bond to itself resulting in the material splitting or tearing apart from itself (i.e. joint sealant splitting).

Cold In-Place Recycled Pavement

A pavement structure composed of an asphalt concrete wearing surface and portland cement concrete slab. An asphalt concrete overlay on a Portland Cement Concrete (PCC) slab is also called a composite pavement.

Control of Access

The condition where the right of owners or occupants of abutting land or other persons to access light, air, or view in connection with a highway is controlled by a public authority.

Collector

A road of the intermediate functional category that collects traffic from the local roads to arterials or distributes traffic to local roads from arterials.

Concrete Overlay (Whitetopping)

The procedure for placing Portland Cement Concrete (PCC) overlays over existing Hot Mix Asphalt (HMA) pavements. Concrete overlay may be either conventional, thin, or ultra-thin depending on the required thickness of the PCC overlay. In general, conventional Concrete overlay uses 8 inches or greater.

- Thin concrete overlay uses greater than 4 but less than 8 inches.
- Ultra-thin concrete overlay uses 4 inches or less thickness of PCC overlay.

Constant Dollars

Un-inflated dollars that represent the prevailing prices for all elements at the base year for the analysis.

Corner Break

A portion of a jointed concrete pavement separated from the slab by a diagonal crack intersecting the transverse and longitudinal joint, which extends down through the slab allowing the corner to move independently from the rest of the slab.

Corrective Maintenance

Corrective maintenance could be a planned or unplanned strategy that restores the existing roadway to the intended design life. Typically, this process occurs within the first five years after construction.

Cross-Stitching

A repair technique for longitudinal cracks and joints that are in reasonably good condition. The purpose of cross-stitching is to maintain aggregate interlock and provide added reinforcement and strength to the crack or joint. The technique uses deformed tie bars inserted into holes drilled across a crack at angles of 35 to 45 degrees depending on slab thickness.

DARWin™

A software program that performs the complex calculations for design and analysis of pavement structures. DARWin™ is an acronym for Design, Analysis, and Rehabilitation for Windows.

Deflection Analysis

The procedure used to establish pavement strength indices based on pavement deflections induced by a force.

Deformed Bar

A reinforcing bar for rigid slabs. Most often used to tie slabs together in the longitudinal direction across lane lines including tying travel lanes and shoulders.

Design Period

The number of years from initial construction or rehabilitation until terminal service life. This term should not be confused with pavement life or analysis period. By adding asphalt overlays as required, pavement life may be extended indefinitely or until geometric considerations or other factors make the pavement obsolete. The initial design period is the number of years for which the volume and type of traffic and the resultant wheel or axle load application are forecast, and on which pavement designs are calculated.

Design Traffic (18k ESAL)

The design traffic is the total number of equivalent 18,000-lb single axle load (18k ESAL) applications expected during the design period. This can be calculated or obtained from CDOT personnel at the Traffic Analysis Unit of the Division of Transportation Development.

Deterministic Life Cycle Cost Analysis

A traditional cost comparison process where each item of interest is assigned a fixed discrete value, usually a value most likely to occur based on historical data and user judgement. This value includes all costs over the life of the project, such as construction, maintenance, and rehabilitation adjusted to a present value.

Diamond Grinding

A process of improving a pavement's ride by creating a smooth, uniform profile by removing faulting, slab warping, studded tire wear, and patching unevenness.

Discount Rate

A value in percent used for comparing the alternative uses of funds over a period of time. The discount rate may be defined as the difference between the market interest rate and inflation rate using constant dollars over the analysis period.

Dowel

A load transfer device in a rigid slab usually consisting of a plain, epoxy coated, round steel bar. Most often used to provide load transfer between slabs in the transverse direction that are within the same lane.

Drainage Coefficients

Factors used to modify structural layer coefficients in flexible pavements, or stresses in rigid pavements as a function of how well the pavement structure can handle the adverse effect of water infiltration.

Durability Cracking

The breakup of concrete due to freeze-thaw expansive pressures within certain aggregates. Also called D-Cracking.

Economic Analysis

A justification of the expenditure required and the comparative worth of a proposed improvement as compared to other alternate plans.

Economic Life

Economic life is the total useful life of a pavement structure including the extended service life gained when the initial pavement is supplemented by the addition of structural layers. It also defines the period of time beyond which further use is not economical.

Edge Cracking

Fracture and material loss in pavements without paved shoulders which occurs along the pavement perimeter. Caused by soil movement beneath the pavement.

Embankment (Embankment Soil)

The prepared or natural soil underlying the pavement structure.

Emulsified Asphalt Treated Base

A base consisting of a mixture of mineral aggregate and emulsified asphalt spread on a subgrade to support a surface course.

Equivalence Factor

A numerical factor that expresses the relationship of a given axle load in terms of their effect on the serviceability of a pavement structure. All axle loads are equated in terms of the equivalent number of repetitions of an 18,000-pound single axle.

Equivalent Single Axle Loads (ESALs)

The effect on pavement performance of any combination of axle loads of varying magnitude expressed in terms of the number of 18,000-lb single-axle loads required to produce an equivalent effect. This is calculated by summing the equivalent 18,000-pound single axle loads (18k ESALs) used to combine mixed traffic to design traffic for the design period. The value of 18k ESALs is obtained as an accumulative total from the beginning of use until and including the design year. The 18k ESAL is calculated by multiplying the annual design traffic volume by the Traffic Equivalence Factor (e) at a given Terminal Serviceability Index (P_t).

Expansion Factor

A factor expressing the expected traffic growth trend on a particular section of highway.

Expressway

A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at major intersections.

Fatigue Cracking

A series of small, jagged, interconnecting cracks caused by failure of the asphalt concrete surface under repeated traffic loading (also called alligator cracking).

Fault

Difference in elevation between opposing sides of a joint or crack.

Flexible Pavement

A pavement structure of which the surface course is made of asphaltic concrete, that maintains intimate contact with and distributes loads to the subbase or subgrade and depends upon aggregate interlock, particle friction, and cohesion for stability.

Foamed Asphalt Stabilized Base

A base consisting of mixed wet unheated aggregates and asphalt cement while the asphalt cement is in a foamed state.

Fog Seal

A seal coat consisting of an application of diluted asphalt emulsion without an aggregate cover.

Free Edge

Pavement border that is able to move freely.

Freeway

An expressway with full control of access and all at-grade intersections eliminated.

Full Depth Asphalt

A asphaltic concrete pavement structure consisting of one and only one layer. There is no base, subbase, or intermediary layer of gravel between the asphaltic concrete layer and subgrade.

Full Depth Reclamation

A rehabilitation technique in which the full thickness of asphalt pavement and a predetermined portion of the underlying materials (base, subbase and/or subgrade) is uniformly pulverized and blended to provide an upgraded, homogeneous base material. This new stabilized base course may be used for an asphalt or concrete wearing surface.

Functional Deficiency

Any condition that adversely affects the roadway user. These include poor surface friction and texture, hydroplaning and splash from wheel path rutting, and excess surface distortion.

Functional Maintenance

A planned strategy of low cost treatments that are meant to sustain the roadway and its appurtenances in a manner that delivers a condition in order to keep traffic moving.

Grade Separation

A crossing of two highways, or a highway and a railroad, at different levels.

Granular Base

A base consisting of mineral aggregate laid and compacted on a subbase or subgrade to support a surface course.

Grooving

Grooving restores skid resistance to concrete pavements. It increases the surface friction and surface drainage capabilities of a pavement by creating small longitudinal or transverse channels that drain water from underneath the tire, reducing the potential for hydroplaning.

Hairline Crack

A fracture that is very narrow in width, less than 0.125 inches (3 mm).

Hinged Joint

A joint between two rigid pavement slabs in which flexure is permitted but separation and vertical displacement of abutting rigid slabs are prevented by metal ties and mechanical or aggregate interlock.

Hot Bituminous Pavement

A combination of mineral aggregate and bituminous material, mixed in a central plant, laid and compacted while hot, to act as a surface course and carry traffic. Hot Bituminous Pavement is an older design usage. Also known as Plant Mixed Bituminous Pavement, see Hot Mix Asphalt for current designation.

Hot In-Place Recycled Pavement: Heater Remixing

A pavement rehabilitation process that consists of reworking the existing pavement with a heating device, reshaping, and compaction. This operation may be performed with or without the addition of a rejuvenating agent, aggregates, or new asphalt mix.

Hot In-Place Recycled Pavement: Heater Repaving

A pavement rehabilitation process that consists of reworking the existing pavement with a heating device. During the lay down process of the old rejuvenated material, a virgin lift will be added reshaped and compacted.

Hot In-Place Recycled Pavement: Heater Scarifying

A pavement rehabilitation process that consists of reworking the existing pavement with a heating device. A rejuvenating agent will be added to the old mix reshaped and compacted.

Hveem Stabilometer

A device for the measurement of the lateral pressure transmitted by a soil or aggregate being subjected to a vertical load. The pressure obtained is used to compute the R-value, which is the internal resistance or the internal friction property of a bituminous pavement or a base. The data obtained is used to compute the relative stability.

Hydroplaning

To skid on wet pavement because water on the pavement causes the tires to lose contact with it.

Joint Seal Damage

Any distress associated with the joint sealant, or lack of joint sealant.

Keyway

A groove on either vertical or horizontal face of a concrete slab. A keyway is often molded in concrete structures. A keyway molded on a vertical face of a concrete slab will provide interlock and load transfer to an adjacent slab. A keyway molded on a horizontal face of a concrete structure will provide interlock and resist horizontal movement of a concrete structure molded over the keyway.

Lane Factor

Factors used to convert total truck traffic to Design Lane Truck Traffic given the number of lanes.

Lanes to Shoulder Drop-off

The difference in elevation between the traffic lane and the shoulder.

Lane to Shoulder Separation

Widening of the joint between the traffic lane and the shoulder.

Lime-Treated Base

A base consisting of a mixture of soil, hydrated lime, and water usually mixed in place and placed to support a pavement structure, or the components thereof.

Load Transfer Device

A mechanical means designed to carry loads across a joint in a rigid slab.

Local Street or Local Road

A street or road primarily for access to residence, business, or other abutting property.

Longitudinal

Parallel to the pavement centerline.

Low Volume Road

A road with a two-directional Average Annual Daily Traffic (AADT) of less than 100 trucks per day and less than 1,000 cars per day.

Maintenance

The preservation of the entire roadway, including surface, shoulders, roadsides, structures, and such traffic control devices as are necessary for its safe and efficient utilization.

Major Rehabilitation

Pavement treatments that consist of structural enhancements that extend the serviceable life of an existing pavement and improve its load-carrying capability.

Map Cracking

A series of interconnected hairline cracks in portland cement concrete pavements that extend only into the upper surface of the concrete. It includes cracking typically associated with Alkali-Silica Reactivity (ASR).

Mechanistic-Empirical Pavement Design Guide

The guide and its accompanying software that provides a uniform basis for the design of flexible, rigid, and composite pavements, using mechanistic-empirical approaches which are more realistically characterize in-service pavements and improve the reliability of designs.

Micro-Surfacing

A seal coat consisting of the application of polymer modified emulsion followed by a cover of aggregates selected for properties of hardness and angularity.

Minor Rehabilitation

Pavement treatments consisting of functional or structural enhancements made to the existing pavement sections to improve pavement performance or extend serviceable life.

Modulus of Elasticity (E)

A measure of the rigidity of a material and its ability to distribute loads defined by the ratio of strain to stress in a portland cement concrete pavement slab.

Modulus of Subgrade Reaction (k-value)

Westergard's modulus of subgrade reaction for use in rigid pavement design (the load in pounds per square inch on a loaded area of the roadbed soil or subbase divided by the deflection, in inches, of the roadbed soil or subbase), psi/in. The modulus of subgrade reaction is the supporting capability of a soil measured by its ability to resist penetration of a series of loaded stacked plates.

Modulus of Rupture (S'_c)

An index of the flexural strength of the portland cement concrete pavement. It is a measure of the extreme fiber stress developing under slab bending, the mode in which most concrete pavements are loaded. The modulus of rupture required by the design procedure is the mean value determined after 28 days using third-point-loading (AASHTO T97).

Nominal Maximum Aggregate Size

One sieve size larger than the first sieve to retain more than 10 percent of the material (Roberts et al., 1996).

Overlays

- **Leveling Course:** The layer of material placed on an existing paved surface to eliminate irregularities prior to placing an overlay or a surface course. Milling procedures are to be considered the primary method to address rutting and are to be used instead of a leveling course to remove ruts whenever possible.
- **Overlay Course:** Surfacing course, either plant mixed or road mixed, placed over an existing pavement structure after placement of a leveling course, as appropriate.

Partial Depth Reclamation

A rehabilitation technique in which a portion of the asphalt pavement is pulverized, mixed with a stabilizing agent, and placed back on the remaining pavement surface. Partial depth reclamation is limited to correcting only those distresses that are surface problems in the asphalt layer.

Patch

An area where the pavement has been removed and replaced with a new material.

Patch Deterioration

Distress occurring within a previously repaired area.

Pavement

The part of roadway having a constructed surface for the facilitation of vehicular movement.

Pavement Design (Design, Structure Design)

The specifications for materials and thickness of the pavement components.

Pavement Joints

The designed vertical planes of separation or weakness. Complete details of concrete pavement joints are given a standard specifications in CDOT's *Standard Plans M & S Standards*.

Joints Used in Portland Cement Concrete Pavement

- **Construction Joints:** Joints made necessary by a prolonged interruption in placing concrete. They are formed by placing concrete up to one side of a planned joint and allowing it to set before the concrete is placed on the other side of a joint. They may be either longitudinal or transverse.
- **Contraction Joints:** Joints placed either transversely at recurrent intervals or longitudinally between traffic lanes to control cracking.
- **Expansion Joints:** Transverse joints located to provide for expansion without damage to themselves, adjacent slabs, or structures.
- **Weakened Plane Joints (Longitudinal and Transverse):** Weakened plane joints are placed both longitudinally and transversely in PCCP. CDOT specifies using a saw to cut the weakened planes at $\frac{1}{3}$ in PCCP.

Pavement Maintenance

Typically, these treatments are preventive in nature and are intended to keep the pavement in serviceable condition. They may be classified as corrective, preventive, reactive, or functional.

Pavement Management

Pavement management is the evaluation, documentation, and analysis of the amount, quality, and type of pavement under the responsibility of any given owner or agency. It is also the planning and budgeting for the upkeep and replacement of paved assets.

Pavement Performance

The trend of serviceability with load applications.

Pavement Rehabilitation

Work undertaken to extend the service life of an existing facility. This includes placement of additional surfacing material and/or completing any other work necessary to return an existing roadway, including shoulders, to a condition of structural or functional adequacy. This could include the complete removal and replacement of the pavement structure.

Pavement Structure

The combination of subbase, base course, and surface course placed on a prepared subgrade to support the traffic load and distribute it to the roadbed.

Pavement Section

A layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. Most soils can be adequately represented for pavement design purposes by means of the soil support value for flexible pavements and a modulus of subgrade reaction for rigid pavements

Performance Period

The period of time that the initially constructed or rehabilitated pavement structure will last (perform) before reaching its terminal serviceability. This is also called the design period.

Permeability

The property of soils which permits the passage of any fluid. Permeability depends on grain size, void ratio, shape, and arrangement of pores.

Plant Mixed Bituminous Base

A base consisting of mineral aggregate and bituminous materials mixed in a central plant, and laid and compacted while hot on a subbase or a subgrade to support a surface course.

Plant Mixed Bituminous Pavement

A combination of mineral aggregate and bituminous material mixed in a central plant, laid and compacted while hot to act as a surface course and carry traffic. Plant Mixed Bituminous Pavement is an older designation usage. Also known as Hot Bituminous Pavement, see Hot Mix Asphalt for current designation.

Plant Mixed Seal Coat

A seal coat consisting of a combination of mineral aggregate and bituminous material mixed in a central plant, laid, and compacted while hot.

Polished Aggregate

Surface mortar and texturing worn away to expose coarse aggregate in the concrete.

Popouts

Small pieces of pavement broken loose from the surface.

Pothole

A bowl-shaped depression in the pavement surface.

Prepared Roadbed

In place roadbed soils compacted or stabilized according to provisions of applicable specifications.

Present Serviceability Index (PSI)

A number derived by a formula for estimating the serviceability rating calculated from measurements of certain physical features of the pavement.

Preventive Maintenance

Preventive maintenance is a planned strategy of cost-effective treatments performed on an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without significantly increasing the structural capacity.

Prime Coat

Bituminous materials used on aggregate base courses to provide good adhesion to the hot mix asphalt layer placed above.

Probabilistic Life Cycle Cost Analysis

A process where probabilistic LCCA inputs are described by probability functions that convey both the range of likely inputs and the likelihood of their occurrence. Probabilistic LCCA also allows for the simultaneous computation of differing assumptions for many different variables. Probabilistic LCCA allow the value of individual data inputs to be defined by a frequency (probability) distribution.

Pumping

The ejection of foundation material, either wet or dry, through joints or cracks, or along edges of rigid slabs resulting from vertical movements of the slab.

Punchout

A localized area of a continuously reinforced concrete pavement bounded by two transverse cracks and a longitudinal crack. Aggregate interlock decreases over time and is eventually lost which leads to steel rupture and allows the pieces to be punched down into the subbase and subgrade.

Raveling

The wearing away of the pavement surface caused by the dislodging of aggregate particles.

Reactive Maintenance

Reactive maintenance is an unplanned, therefore, unscheduled; sometimes immediate treatments performed on an existing roadway system and its appurtenances that is necessary to avoid serious consequences.

Reconstruction

Treatments requiring full removal and replacement and or improvement of the existing pavement structure which includes subbase, base course, and surface course due to pavement condition and structural capabilities. A LCCA is required. Typical AASHTO criteria are addressed and designed to current standards.

Reflection Cracking

The fracture of asphalt concrete above joints in the underlying pavement layer(s).

Reinforcement

Steel embedded in a rigid slab to resist tensile stresses and detrimental opening of cracks.

Reliability

The probability, expressed as a percentage that a pavement structure will carry the traffic for which it is designed over the design or analysis period.

Remaining Service Life (RSL)

The number of years a pavement is expected to last until maintenance and rehabilitation treatments no longer improve or maintain the surface condition.

Resilient Modulus (M_r)

A measure of the modulus of elasticity of roadbed soil or other pavement material. In M-E Design, the subgrade resilient modulus M_r is measured at optimum moisture content and density. This M_r is different than the AASHTO 1993 empirical design procedure which was basically a “wet of optimum” M_r . The input M_r is then internally adjusted to field conditions by the M-E Design software on a month to month basis based on water table depth, precipitation, temperature, soil suction, and other factors.

Rigid Pavement

A pavement structure of which the surface course is made of portland cement concrete.

Rigid Slab

A section of portland cement concrete pavement bounded by joints and edges designed for continuity of flexural stress.

Roadbed

The graded portion of a highway within top and side slopes prepared as a foundation for the pavement structure and shoulder.

Roadbed Material

The material below the pavement structure in cuts and embankments and in embankment foundations, extending to such depth as affects the support of the pavement structure.

Roadway

The portion of a highway including shoulders, for vehicular use.

Roundabout

A circular intersection with yield control of all entering traffic, channelized approaches, counter-clockwise circulation, and appropriate geometric curvature to ensure travel speeds on the circulatory roadway are typically less than 30 miles per hour.

Rutting

Longitudinal surface depressions in the wheel paths.

Sand Seal

A seal coat consisting of the application of asphalt emulsion followed by a sand cover aggregate.

Scaling

The deterioration of the upper 0.125 to 0.5 inches of the concrete surface, resulting in the loss of surface mortar.

Seal Coat

A thin treatment consisting of bituminous material, usually with cover aggregate, applied to a surface as an armor coat or for delineation. The term includes but is not limited to sand seal, chip seal, slurry seal, and fog seal.

Service Life

The service life is the number of years a pavement is expected to last from completion of construction until pavement failure.

Serviceability

The ability, at the time of observation, of a pavement to serve traffic using the facility. Also, serviceability is a pavement's ability to provide adequate support and a satisfactory ride at any specific time.

Serviceability Index

A number that is indicative of the pavement's ability to serve traffic at any specific time in its life.

Shoving

Permanent, longitudinal displacement of a localized area of the pavement surface caused by traffic pushing against the pavement.

Single Axle Load

The total load transmitted by all wheels whose centers may be included between two parallel transverse vertical planes 40 inches apart and extending across the full width of the vehicle.

Skid Hazard

Any condition that might contribute to making a pavement slippery when wet.

Slot Stitching

A technique for repairing longitudinal cracks or joints. It is an extension of dowel bar retrofit, which is used to add dowel bars to existing transverse joints. The purpose of slot-stitching is to provide positive mechanical interconnection between two slabs or segments. The deformed bars placed in the slots hold the segments together serving to maintain aggregate interlock and provide added reinforcement and strength to the crack or joint. The bars also prevent the crack or joint from vertical and horizontal movement or widening. Larger diameter bars (> 25mm, > 1 inch) also serve to provide long-term load transfer capabilities.

Slurry Seal

A seal coat consisting of a semi fluid mixture of asphaltic emulsion and fine aggregate. This type of seal is usually placed in a very thin course of $\frac{1}{8}$ to $\frac{1}{4}$ inches.

Soil Support Value

A number that expresses the relative ability of a soil or aggregate mixture to support traffic loads through the pavement structure.

Spalling

Cracking, breaking, chipping, or fraying of the concrete slab surface within 2 feet of a joint or crack.

Squeegee Seal

A seal coat similar to a sand seal, consisting of the application of asphalt emulsion and sand. The application of a squeegee seal differs from that of a sand seal in that a surface drag is used to spread the emulsion to seal cracks

Stabilometer R-Value

A numerical value expressing the measure of a soil's or aggregate's ability to resist the transmission of vertical load in a lateral or horizontal direction. A test for evaluating bases, subbases, and subgrades for pavement thickness design. It is measured with a stabilometer.

Standard Normal Deviate (Z_R)

The standard normal deviate is a statistical value identical to the Z-scale value used in the standard normal distribution. It is a measure of the deviation of any observations from the mean of all observations expressed in terms of the number of standard deviations. Each calculated Z value corresponds to a certain level of significance, confidence interval, certainty, or reliability value in a standard normal distribution curve. The standard normal deviate (Z) can be calculated from the equation:

$$Z = \frac{\text{Observed Value} - \text{Mean of all Observed Values}}{\text{Standard Deviation of all Observations}}$$

Stone Matrix Asphalt (SMA)

A mixture of crushed coarse aggregate, crushed fine aggregate, mineral filler, asphalt cement, and stabilizing agent typically used as a wearing course. A stabilizing agent is used to prevent drain down of the asphalt cement and typically consists of fibers, polymers, or limestone dust (powder).

Structural Deficiency

Any condition that adversely affects the load carrying capability of the pavement structure. These include inadequate thickness, cracking, distortion, and disintegration. Several types of distress (i.e., caused by poor construction techniques, low temperature cracking) are not initially caused by traffic loads, but do become more severe under traffic to the point that they also detract from the load carrying capability of the pavement.

Structural Layer Coefficient (a_1 , a_2 , a_3)

The empirical relationship between structural number (SN) and layer thickness that expresses the relative ability of a material to function as a structural component of the pavement and express the relative strength of a layer in a pavement structure.

Structural Number (SN)

An index derived from an analysis of traffic, roadbed soil conditions, and environment that may be converted to thickness of flexible pavement layers by using suitable structural layer coefficients related to the type of materials being used in each layer of the pavement structure.

Subbase

The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course. Subgrade treated with lime, fly ash, cement kiln dust, or combination of stabilization will be considered subbase.

Subgrade

The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

Surface Course

The uppermost component of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is also sometimes called the wearing course.

Surface Life

A period of time where treatments can be performed on a pavement that maintain or improve the surface condition.

Tack Coat

A light application of emulsified asphalt applied to an existing asphalt or portland cement concrete pavement surface. It is used to ensure a bond between the surface being paved and the overlaying course. Typically 0.10 gal/yd² of diluted CSS1h.

Tandem Axle Load

The total load transmitted to the road by two consecutive axles whose centers may be included between parallel vertical planes spaced more than 40 inches but not more than 96 inches apart, extending across the full width of the vehicle.

Tie Bar

A deformed steel bar or connector embedded across a longitudinal joint for a rigid slab to prevent separation of abutting slabs.

Tining

A process by which it is achieved by a mechanical device equipped with a tining head (metal rake) that moves laterally across the width of the paving surface.

Treated Base

A layer of base material stabilized with asphalt, portland cement, or other suitable stabilizers.

Traffic Equivalence Factor (e)

A numerical factor that expresses the relationship of a given axle load to another axle load in terms of their effect on the serviceability of a pavement structure.

Transverse

Perpendicular to the pavement centerline.

Triple Axle Load

The total load transmitted to the road by three consecutive axles whose centers may be included between parallel planes spaced more than 40 inches but no more than 96 inches apart, extending across the full width of the vehicle.

Water Bleeding

Seepage of water from joints or cracks.

Weathering

The wearing away of the pavement surface caused by the loss of asphalt binder.

Weigh-In-Motion (WIM) Station

The process of measuring the dynamic tire forces of a moving vehicle and estimating the corresponding tire loads of the static vehicle.

Welded Wire Fabric (WWR)

A two-way reinforcement system for rigid slabs, fabricated from cold-drawn steel wire and having parallel longitudinal wires welded at regular intervals to parallel transverse wires. The wires may be either smooth or deformed.

Whitetopping (old definition)

The procedure for placing portland cement concrete overlays over existing hot mix asphalt pavements. Whitetopping may be either conventional, thin, or ultra-thin depending on the required thickness of the PCC overlay. In general, conventional whitetopping uses 8 inches or greater:

- **Thin whitetopping** uses greater than 4 but less than 8 inches.
- **Ultra-thin whitetopping** uses 4 inches or less thickness of a PCC overlay.

MECHANISTIC-EMPIRICAL (M-E) PAVEMENT DESIGN BASIC DEFINITIONS

These definitions may be slightly different from the definition in the previous section. These basic definition as are to agree with the usage as in the Mechanistic-Empirical (M-E) Pavement Design Guide. Some have been modified to clarify this manual's notation.

Basic Definitions of the Roadway

Base: The layer or layers of specified or select material of designed thickness placed on a subbase or subgrade to support surface course. The layer directly beneath the PCC slab is called the base layer.

- **Aggregate Base:** A base course consisting of compacted aggregates which includes granular base and unbound granular base.
- **Asphalt Concrete Base:** Asphalt concrete used as a base course. This may include asphalt base course, hot-mixed asphalt base, asphalt-treated base, bituminous aggregate base, bituminous base, bituminous concrete base, and plant mix bituminous base.
- **Cold Mix Asphalt:** Asphalt concrete mixtures composed of aggregate and/or asphalt emulsions or cutback asphalts, which do not require heating during mixing. This may include emulsified asphalt treated base.
- **Permeable Aggregate Base:** A crushed mineral aggregate base, treated or untreated, having a particle size distribution such that when compacted the interstices will provide enhanced drainage properties. It may include a granular drainable layer, untreated permeable base, free-draining base, and stabilized treated permeable base.
- **Asphalt Treated Permeable Base:** A permeable base containing a small percentage of asphalt cement to enhance stability. This may include asphalt-treated open-graded base or asphalt treat base; permeable.
- **Cement Treated Base:** A base course consisting of mineral aggregates blended in place or through a pugmill with a small percentage of portland cement to provide cementitious properties and strengthening. This may also include aggregate cement, cement-stabilized graded aggregate, and cement-stabilized base.
- **Lean Concrete Base:** A base course constructed of plant mixed mineral aggregates with a sufficient quantity of portland cement to provide a strong platform for additional pavement layers and placed with a paver.
- **Lime-Fly Ash Base:** A blend of mineral aggregate, lime, fly ash, and water combined in proper proportions and producing a dense mass when compacted.

- **Cement Treated Permeable Base:** An open-graded aggregate base treated with portland cement to provide enhanced base strength and reduce erosion potential.

Fabric Layers

- **Geosynthetics:** A planar material manufactured from a polymeric material used with soil, rock, earth, or other geotechnical-related materials. It serves six primary functions: filtration, drainage, separation, reinforcement, fluid blockage, and protection. Typical geosynthetics include geotextiles, geomembranes, and geogrids.
- **Geotextiles:** Permeable fabric made of textile materials used as filters to prevent soil migration, separators to prevent soil mixing, and reinforcement to add shear strength to a soil.
- **Geomembranes:** Impermeable polymer sheeting used as fluid barriers to prevent migration of liquid pollutants in the soil.
- **Geogrids:** Polymeric grid material having relatively high tensile strength and a uniformly distributed array of large apertures (openings). The apertures allow soil particles on either side to come in direct contact, thereby increasing the interaction between the geogrid and surrounding soils. Geogrids are used primarily for reinforcement.

Roadbed

The graded portion of a highway between top and side slopes, prepared as a foundation for the pavement structure and shoulder.

Subbase

The layer or layers of specified or selected materials of designed thickness placed on a subgrade to support a base course. This may include granular subbase and unbound granular subbase. **Note:** The layer directly below the PCC slab is now called a base layer, not a subbase layer.

Subgrade

The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

- **Select Material:** A suitable native material obtained from a specified source, such as a particular roadway cut or borrow area, having specified characteristics to be used for a specific purpose.
- **Soil Cement:** A mechanically compacted mixture of soil, portland cement, and water used as a layer in a pavement system to reinforce and protect the subgrade or subbase. It may also include cement-treated subgrade.
- **Lime Stabilized Subgrade:** A prepared and mechanically compacted mixture of hydrated lime, water, and soil supporting the pavement system that has been engineered to provide structural support.

Surface Course

One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer of flexible pavements is sometimes called the “wearing” course.

ESTIMATING FORMULAS, CALCULATIONS, AND CONVERSION FACTORS

Estimating Formulas

- **Diluted Emulsified Asphalt:** 0.10 gal./sq. yd. (diluted - slow setting)
- **Bituminous Pavement:** 110 lbs./sq. yd./1" thickness
- **Aggregate Base Course (Class 2 and 6):** 133 lbs./cu. ft.
- **Filter Material:** 110 lbs./cu. ft.
- **Hydrated Lime:** 26.4 lbs./sq. yd./ 8 in. depth at 4% lime
- 39.6 lbs./sq. yd./12 in. depth at 4% lime
- 59.4 lbs./sq. yd./12 in. depth at 6% lime
- **Asphalt Rejuvenating Agent:** 0.15 gal./sq. yd. (diluted)
- **Asphalt Rejuvenating Agent:** 0.15 gal./sq. yd. (non-diluted asphalt rejuvenating agent for use with Item 404 - Heater and Scarifying Treatment)
- **Micro-Surfacing Seal Coat:** 35 lbs./sq. yd. (based on an average rut depth of $\frac{3}{4}$ inches)
- **Crack Sealant:** quantities of crack sealant were estimated based on the level of cracking and the following ratios. The quantities shown here are for information only.
 - Heavy: 2 tons per lane mile
 - Medium: 1 ton per lane mile
 - Light: 0.5 ton per lane mile
 - Very Light: 0.25 ton per lane mile

Conversion Factors

- 1 ton = 0.90718 metric ton
- 1 lb/cu. ft = 16.018 kg/cu. meter
- 1 psi/in. = 0.271 kpa/mm
- 0.10 gal./sq. yd. = 0.453 L/sq. meter
- 0.15 gal./sq. yd. = 0.70 L/sq. meter
- 110 lbs/sq. yd./one inch = 2.34 kg/sq. meter/25.4 millimeter
- 110 lbs/cu. ft. = 1762 kg./cu. meter
- 133 lbs/cu. ft. = 2130 kg/cu. meter
- inches = 50.8 mm or 50 mm (rounded for pavement design)
- inches = 101.6 mm or 100 mm (rounded for pavement design)
- $\frac{1}{2}$ inch = 12.7 mm or 12.5 (rounded for pavement design)
- A U.S. gallon (determined by fluid volume at 72°F, at sea level) of fresh water weighs exactly 8.3452641 lbs.

Incentive/Disincentive Calculations

$$I/DP = (PF - 1) \times (QR) \times (UP) \times (W \div 100)$$

Where: I/DP = Incentive/disincentive payment
PF = Pay factor
QR = Quantity in tons of HMA represented by the process
UP = Unit bid price of asphalt mix
W = Element factor from Table 105-2 of *CDOT's Standards and Specifications*

When AC is Paid for Separately UP Shall Be:

$$UP = [(Ton_{HMA}) \times (UP_{HMA}) + (Ton_{AC}) \times (UP_{AC})] \div Ton_{HMA}$$

Where: Ton_{HMA} = Tons of asphalt mix
UP_{HMA} = Unit bid price of asphalt mix
Ton_{AC} = Tons of asphalt cement
UP_{AC} = Unit bid price of asphalt cement

For the Joint Density Element:

$$UP = UP_{HMA}$$

Where: UP_{HMA} = Unit Bid Price of Asphalt Mix

When AC is Paid for Separately UP Shall Be:

$$UP = [(B Ton_{HMA}) \times (BUP_{HMA}) + (B Ton_{AC}) \times (BUP_{AC})] \div B Ton_{HMA}$$

Where: B Ton_{HMA} = Bid tons of asphalt mix
BUP_{HMA} = Unit bid price of asphalt mix
B Ton_{AC} = Bid tons of asphalt cement
BUP_{AC} = Unit bid Price of asphalt cement