



Economic Commission for Europe**Inland Transport Committee****Working Party on Transport Trends and Economics****Group of Experts on Benchmarking Transport Infrastructure Construction Costs****Fifth session**

Geneva, 30 and 31 January 2018

Item 3 of the provisional agenda

Transport Infrastructure Construction costs:**Presentations of terminologies used****Revised terminology on Benchmarking Road Transport Infrastructure Construction Costs****Note by the Group of Experts****I. Mandate**

1. In accordance with its Terms of Reference, the Group of Experts is expected to complete its work within two years (2016-2018) and to submit a full report of its accomplishments (ECE/TRANS/WP.5/GE.4/2016/1). The Group of Experts shall assist in:

(a) Identify models, methodologies, tools and good practices for evaluating, calculating and analysing inland transport infrastructure construction costs;

(b) Identify and list terminologies used in UNECE region for construction costs of inland transport infrastructure, if possible, create a glossary of agreed terminologies and related explanations;

(c) Collect and analyse data in order to prepare a benchmarking of transport infrastructure construction costs along the ECE region for each inland transport mode - road, rail, inland waterways - including intermodal terminals, freight/logistics centres and ports. Analyse and describe the conditions / parameters under which these costs have been calculated on.

2. In carrying out its main tasks, the Group of Experts will, among others, also identify suitable methodological approaches, models and tools for gathering and disseminating information, i.e. conducting studies, distributing questionnaires, using existing studies and national strategies, existing best practices in calculating transport infrastructure construction costs, among others.

II. Terminology

3. Abutment: an abutment is the part of a bridge consisting of the cap, backwall, and wingwalls at the ends of a bridge which supports the superstructure, contains the earth in the approach fills, and directly receives the impact loads produced by traffic passing from the roadway onto the bridge. An abutment is a wall supporting the end of a bridge or span, and sustaining the pressure of the abutting earth (11).
4. Access: The driveway by which vehicles and/or pedestrians enter and/or leave property adjacent to a road (14).
5. Access control: The condition whereby the road agency either partially or fully controls the right of abutting landowners to direct access to and from a public highway or road (12).
6. Acquisition: Acquisition is the process of obtaining right of way by negotiation and/or eminent domain proceedings. Negotiation would involve getting the owner to convey, dedicate, or possibly option the property to the public agency. Just compensation must be paid in all acquisitions or takings (11).
7. Acquisition cost: All costs included in acquiring an asset by purchase/lease or construction procurement route, excluding costs during the occupation and use or end-of-life phases of the life cycle of the constructed asset (1).
8. Activity: A specific action performed by the highway agency or the contractor, such as initial construction or major rehabilitation. An activity is defined by its physical costs, its service life, and its effects on highway users. An activity is a component of an alternative (5).
9. Administrative Costs: Costs incurred in contract management administration overhead expenses (5).
10. Agency: A government organization responsible for initiating and carrying forward a highway program for the general public. May refer to a federal highway agency, state transportation department, metropolitan planning organization, local government organization, and so forth (5).
11. Aggregate: Granular material of natural, manufactured or recycled origin used in construction (9).
12. Alternative contracting: Type of contract that is executed in ways other than traditional design-bid-build type (5).
13. Analysis period: The time period used for comparing pavement-type alternatives. An analysis period may contain several maintenance and rehabilitation activities during the life cycle of the pavement being evaluated. The analysis period should not be confused with the pavement design or service life (5).
14. Anionic Bituminous Emulsion: Emulsion in which the emulsifier imparts negative charges to the dispersed bitumen droplets (8).
15. Annual budget:
 - (a) The annual budget is the total budget as approved by the legislature.
 - (b) The annual budget is a group of appropriations which the department has the authority to expend or encumber in a fiscal year (11).

16. Arterial: Highway designed to move relatively large volumes of traffic at high speeds over long distances. Typically, arterials offer little or no access to abutting properties (12).
17. Asphalt: Homogenous mixture typically of coarse and fine aggregates, filler aggregate and bituminous binder which is used in the construction of a pavement. Note 1 to entry: Asphalt can include one or more additives to enhance the laying characteristics, performance or appearance of the mixture (10).
18. Asphalt binder: Asphalt binder, which can be asphalt cement or modified asphalt cement, acts as a binding agent to glue aggregate particles into a cohesive mass (11).
19. Asphalt cement: Asphalt cement is that which has been specifically prepared or refined to standards of quality and consistency. It is prepared for direct use in the manufacture of asphalt pavements (11).
20. Asphalt Concrete (AC): Asphalt in which the aggregate particles are continuously graded or gap-graded to form an interlocking structure (10).
21. Asphaltic Concrete Pavement (ACP): Asphaltic concrete pavement is a compacted mixture of mineral aggregate and asphaltic materials. An ACP overlay is a supplemental base-pavement or wearing surface placed on an existing base-pavement or wearing surface where major repairs to a pavement structure are required to restore a satisfactory riding surface or upgrade the strength of the pavement structure (11).
22. Asphalt Concrete for very thin layers (AC-TL): Asphalt for surface courses with a thickness of 20 mm to 30 mm, in which the aggregate particles are generally gap-graded to form a stone to stone contact and to provide an open surface texture (10).
23. Asphalt for Ultra-Thin Layers (AUTL): Asphalt for Ultra-Thin Layers (AUTL) is a hot mix asphalt road surface course laid on a bonding layer, at a nominal thickness between 10 mm and 20 mm with properties suitable for the intended use. The method of bonding is an essential part of the process and the final product is a combination of the bonding system and the bituminous mixture (10).
24. Asphalt pavement: A structure consisting of one or more layers of asphalt mix resting on a subgrade (16).
25. At-grade: At-grade means a combination of horizontal alignments and vertical grade lines which intersect (11).
26. Backfill:
- (a) Backfill is the material used to replace other material removed during construction.
 - (b) Backfill is the material placed adjacent to structures (11).
26. Base: The layer used in a pavement system to reinforce and protect the subgrade or subbase (17).
27. Benefit /Cost Ratio (B/C): B/C is used to compare the benefit versus the cost of proposed alternatives. For highway projects, benefits may include reduced fuel consumption, travel time, and air pollution; costs may include construction, right of way, and maintenance (11).
28. Balanced cantilever bridge: Balanced cantilever bridges are adopted for comparatively longer spans where simply supported, continuous or rigid frame type superstructures are found unsuitable. For small footbridges, the cantilevers may be simple beams; however, large mixed loads. Prestressed concrete balanced cantilever bridges are often built using segmental construction (7).

29. Binder: Material serving to adhere to aggregate and ensure cohesion of the mixture. Note 1 to entry: Any solid support may be adhered with the binder (8).
30. Binder Course: Structural part of the pavement between the surface course and the base (10).
31. Bio-Fluxed Bitumen: Bitumen whose viscosity has been reduced by the addition of a flux oil derived from vegetal or animal oils (8).
32. Bitumen: Virtually not volatile, adhesive and waterproofing material derived from crude petroleum, or present in natural asphalt, which is completely or nearly completely soluble in toluene, and very viscous or nearly solid at ambient temperatures (8).
33. Bituminous Binder: Adhesive material containing bitumen. Note 1 to entry: A bituminous binder may be in any of the following forms: unmodified, modified, oxidized, cut-back, fluxed, emulsified. Note 2 to entry: To avoid uncertainty, whenever possible the term describing the actual binder in question should be used (8).
34. Bituminous Emulsion: Emulsion in which the dispersed phase is bituminous. Note 1 to entry: Unless otherwise stated, continuous phase is assumed to be aqueous solution (8).
35. Borrow: Borrow is suitable material used for embankments. Borrow is excavating, removing and properly using materials obtained from approved sources of the right of way. Delivered borrow is borrow obtained by the contractor from sources other than the right of way (11).
36. Bridge:
- (a) A bridge is a structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway; having a roadway or track for carrying traffic or other moving loads; and having an opening measured along the centre of the roadway of more than 20 feet between faces of abutments, spring lines of arches, or extreme ends of the openings for multiple box culverts or multiple pipes that are 60 inches or more in diameter and that have a clear distance between openings of less than half of the smallest pipe diameter.
 - (b) A bridge is a product that connects a local area network (LAN) to another local area network that uses the same protocol (for example, Ethernet or Token Ring network) (11).
37. Bridge reconstruction: It is a new bridge construction to replace the existing bridge (7).
38. Bridge rehabilitation: Rehabilitation and repairing of an existing bridge with recovering. This definition is not valid for suspension bridges and similar ones bearing special construction techniques (7).
39. Box culvert: Culvert with a square or rectangular cross-sectional profile having four sides, including a bottom (13).
40. Budget: A budget is a financial plan, actual or estimated, showing the items on which the expenditure of contract funds are authorized (11).
41. Cable stayed bridge: In cable-stayed bridges the deck is supported at more or less regular distances by cables which are fixed to the top or along a mast protruding from the deck plane. In most cases cable-stayed bridges are self-anchored, i.e. the normal force introduced in the deck by the cables on one side of a mast is compensated by the normal force introduced on the other side (7).
42. Capacity: Transportation facility's ability to accommodate a moving stream of people or vehicles in a given time period (13).

43. Carriageway: The part of a road used by vehicular traffic:
- (a) Single carriageway: a road with only one line in each direction.
 - (b) Dual (double) carriageway: a road on which travelling in opposite direction is separated (see divided highway) (7).
44. Capital Cost: Initial construction costs and costs of initial adaptation where these are treated as capital expenditure. Note 1 to entry: The capital cost may be identical to the acquisition cost if initial adaptation costs are not included (1).
45. Cationic Bituminous Emulsion: emulsion in which the emulsifier imparts positive charges to the dispersed bitumen droplets (8).
46. Centerline C/L, C.L., CL or C-Line: The centerline is a line dividing the roadway from opposite moving traffic. It is a survey line with continuous stationing for the length of the project. Construction plans and right of way maps refer to this line. Horizontal alignment is the centre of the roadbed (11).
47. Coarse Aggregate: Designation given to the larger aggregate sizes with D greater than 4 mm and d greater than or equal to 1 mm (9).
48. Concrete: Concrete is a composite material consisting of a binding medium within which are embedded particles or fragments of aggregate; in hydraulic cement concrete, the binder is formed from a mixture of hydraulic cement and water (11).
49. Construction Product: Item manufactured or processed for incorporation in construction works. Note 1 to entry: Construction products are items supplied by a single responsible body. Note 2 to entry: Adapted from the definition in ISO 6707-1 according to the recommendation of ISO/TC59/AHG Terminology (2).
50. Construction Service: Activity that supports the construction process or subsequent maintenance (Source: EN 15804:2012+A1:2013) (2).
51. Construction Works: Everything that is constructed or results from construction operations. Note 1 to entry: This covers both building and civil engineering works, and both structural and non-structural elements. Note 2 to entry: Adapted from the definition in ISO 6707-1 (2).
52. Construction Administration Cost: The normal cost of administration, management, reporting, design services in construction, and community outreach required in the construction phase of a project (4).
53. Construction Allowance: An amount of additional resources included in an estimate to cover the cost of known but undefined requirements for a construction activity or work item. A construction allowance is a normal cost (4).
54. Construction Contingency: An additional markup applied to cover the cost of undefined and as yet unknown construction requirements that are expected to be zero at completion of construction. Construction contingency is a risk cost (4).
55. Construction Phase: The project development phase that includes advertising the project, awarding the contract, and performing the actual construction (4).
56. Contract:
- (a) A contract is a procurement document between two or more parties which creates an obligation to provide goods or services or perform tasks and which includes offer, acceptance, exchange of consideration, legal sufficiency, a defined contract period, a maximum amount payable, and terms and conditions as appropriate.

(b) A legal contract is a legally binding document that provides determination of responsibilities and liabilities (11).

57. Contractor: Private entity that provides design, construction, and/or maintenance services to a highway agency. May refer to the design-builder or a concessionaire (5).

58. Controlled access highway: A controlled access highway, in accordance with applicable state law, is a state highway on which owners or occupants of abutting lands and other persons are denied access to or from the highway except at such points only and in such manner as may be determined by the department. Maintenance Collection (11).

59. Controlled highways: Controlled highways are those highways officially designated as a part of the Interstate or Primary system of highways (11).

60. Control of Access (COA):

(a) Refers to conditions on certain sections of highways where the right to access the highway by abutting property owners or occupants is fully or partially controlled by a public authority. The Texas Department of Transportation (TxDOT) may acquire property for a designated control of access facility or impose a control of access location for safety and design considerations. Control of access is a purchased property interest.

(b) Full control of access means that the authority to control access is exercised to give preference to through traffic by providing access connections with selected public roads only and by prohibiting crossings at-grade or direct private driveway connections.

(c) Partial control of access means that the authority to control access is exercised to give preference to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossings at grade and some private driveway connections (11).

61. Corrective Maintenance: Activity performed to correct deficiencies that negatively impact the safe, efficient operations of the facility, and future integrity of the pavement section. Corrective maintenance generally is reactive to unforeseen conditions to restore a pavement to an acceptable level of service (5).

62. Correlation Analysis: A statistical technique that is used to study the relationship among variables (5).

63. Corridor: Major area of travel between two points (A corridor may include more than one major route and more than one form of transport) (14).

64. Corridor study: In planning, a corridor is a broad geographical band that follows a general directional flow or connects major sources of trips. It may contain a number of streets, highways and transit lines and routes (11).

65. Cost-based Estimating: A method to estimate the bid cost of a work item by estimating the cost of resources (time, equipment, labour, and materials) for each component task necessary to complete the work item, and then adding a reasonable amount for contractor's overhead and profit (5).

66. Cost: The monetary value or price of a project activity or component that includes the monetary worth of the resources required to perform and complete the activity or component, or to produce the component. A specific cost can be composed of a combination of cost components, including direct labour hours, other direct costs, indirect labour hours, other indirect costs, and purchased price (However, in the earned value management methodology, in some instances, the term cost can represent only labour hours without conversion to monetary worth) (11).

67. Cost per Km: Cost per lane is the average expenditure per lane or centerline highway km (11).
68. Costs: Costs are the values of resources consumed (11).
69. Course: Element of a pavement constructed with a single asphalt mixture. Note 1 to entry: A course can be laid in one or more layers (10).
70. Crack seal: Crack seal is an application of sealing material directly in the cracks of the pavement surface to prevent moisture damage (11).
71. Cross-section: A vertical section, generally at right-angles to the centerline showing the ground. On drawings it commonly shows the road to be constructed, or as constructed (14).
72. Crushed stone: Crushed stone is the product excavated from an in-situ deposit of rock, crushed and processed for construction purposes with substantially all faces resulting from the crushing operation (11).
73. Culvert: A structure, usually for conveying water under a roadway but can also be used as a pedestrian or stock crossing, with a clear span of less than six meters (12).
74. Curb: A curb is a vertical or sloping member along the edge of a pavement or shoulder forming part of a gutter, strengthening or protecting the edge and clearly defining the edge to vehicle drivers. The surface of the curb facing the general direction of the pavement is called the “face” (11).
75. Curvature: Sharpness of a curve (13).
76. Cut: Section of highway or road below natural ground level. Sometimes referred to in other documents as a cutting or excavation (12).
77. Design life: The length of time for which a pavement structure is being designed based on structural distresses and traffic loadings (5).
78. Design period: A period considered appropriate to the function of the road. It is used to determine the total traffic for which the pavement is designed (14).
79. Discounted cost: Resulting cost when the real cost is discounted by the real discount rate or when the nominal cost is discounted by the nominal discount rate (1).
80. Discount rate: The time value of money used as the means of comparing the alternative uses for funds by reducing the future expected costs or benefits to present-day terms. Discount rates are used to reduce various costs or benefits to their present value or to uniform annual costs so that the economics of the various alternatives can be compared (approximately equal to interest minus inflation) (5).
81. Disposal cost: Costs associated with disposal of the asset at the end of its life cycle, including taking account of any asset transfer obligations. Note 1 to entry: Asset transfer obligations could include bringing the assets up to a predefined condition. Note 2 to entry: Income from selling the asset is part of WLC¹, where the residual value of the road infrastructure components, materials and appliances can be included (1).
82. Divided highway: A highway with separate carriageways for traffic moving in opposite directions (12).
83. Double layered Porous Asphalt (2L-PA): The top layer with a grain size 4/8 mm is about 25 mm thick and the second/bottom layer is porous asphalt with a course aggregate

¹ Whole-Life Cost

(11/16 mm). The total thickness is about 70 mm. Because of the finer texture at the top (that gives less tyre vibrations), it gives a better noise reduction than a single layer porous asphalt (10).

84. Drainage: Drainage is the removal of water from the highway right-of-way area by use of culverts, ditches, outsell channels and other drainage structures (14).

85. Drainage structure: And device or land form constructed to intercept and/or aid surface water drainage (13).

86. Earthwork: Earthwork includes the operations connected with excavating and placing embankments with soil, earth or rock (11).

87. Edge line: A line used to differentiate the outer edge of the traffic lanes from the shoulder (14).

88. Embankment: An embankment is a raised structure of soil, soil aggregate, rock or combination of the three. Materials used for fill section (11).

89. Emulsion: Fluid system in which liquid droplets and/or liquid crystals are dispersed in a liquid. Note 1 to entry: Dispersion is thermodynamically metastable (8).

90. End-of-life cost: Net cost or fee for disposing of an asset at the end of its service life or interest period, including costs resulting from, deconstruction and demolition of a road infrastructure; recycling, making environmentally safe and recovery and disposal of components and materials and transport and regulatory costs (1).

91. Estimate: An estimate is the approximate quantity and cost of materials, construction items, and labour required for a specific construction project (11).

92. Excavation: Excavation is the act of cutting, digging, or scooping to remove material (11).

93. Expansion (Capacity Improvement): Same as reconstruction and also involves the construction of additional through travel lanes beyond the work associated with reconstruction (7).

94. Expressway: An expressway is a divided arterial highway for through traffic. An expressway has full or partial control of access and generally has grade separations at major intersections (11).

95. External costs: Costs associated with an asset that are not necessarily reflected in the transaction costs between provider and consumer and that, collectively, are referred to as externalities. Note 1 to entry: These costs may include business staffing, productivity and user costs; these can be taken into account in a LCC² analysis but should be explicitly identified (1).

96. Feasibility Study (FS): A study about a project's feasibility which is summarized in a document. The study addresses issues including the project's benefits, costs, effectiveness, alternatives considered, analysis of alternative selection, environmental effects, public opinions, and other factors (11).

97. Fill: Fill is the embankment material placed above natural ground line (11).

98. Flexible pavement: A pavement structure that maintains intimate contact with and distributes loads to the subgrade and depends on aggregate interlock, particle friction, and cohesion for stability (11).

² Life Cycle Cost

99. Foundation: The foundation is that portion of a structure (usually below the surface of the ground) which distributes the pressure to the soil or to artificial supports. Footing has similar meaning (11).
100. Freeway: Highest level of arterial characterized by full control of access and high design speeds (12).
101. Geometric design: A geometric design refers to the dimensions and elements of a highway or road (11).
102. Geometric improvement: Improvements which focus on increasing intersection capacity and enhancing safety; often involves widening to provide auxiliary turn lanes and the installation or modification of traffic signals (13).
103. Girder: A girder is a horizontal main structural member to a bridge that supports vertical loads (11).
104. Grade:
- (a) A grade is the slope of a roadway, channel, or natural ground.
 - (b) A grade is any surface prepared for the support of construction such as that for paving or laying a conduit (11).
105. Grade controls: Grade controls are automatic controls on an asphalt pavement which compensate for grade variations. A grade control sensor transmits an electronic signal to either thicken or thin out the depth of the asphalt mat. The signals are based upon the grade control sensor resting on the pavement surface or on a string line (11).
106. Grade line: A grade line is the slope in the longitudinal direction of the roadbed, usually expressed in percent, which is the number of units of change in elevation per 100 units' horizontal distance (11).
107. Grade separation: A crossing of two roadways, a roadway and railroad, or a roadway and a pedestrian/bicycle facility at different levels (13).
108. Grading for earthworks:
- (a) Grading means the preparation of a subgrade, in line and elevation, for application of pavement materials including base and surfacing materials.
 - (b) Grading is any striping, cutting, filling, stockpiling, or combination thereof which modifies the land surface (11).
109. Guardrail: A guardrail is a traffic barrier used to shield potentially hazardous areas (11).
110. Highway: Highway is the entire width between the boundary lines of every way publicly maintained when any part thereof is open to the use of the public for purposes of vehicular travel (11).
111. Highway class: Highway class is the rural/urban description of the lane characteristics (11).
112. Highway overpass: A highway-overpass is a grade separation where the subject highway passes over intersecting highway (11).
113. Highway underpass: A highway-underpass is a grade separation where the subject highway passes under an intersecting highway (11).
114. Horizontal curve: Bend from a straight line along a roadway (13).

115. Grading: Particle size distribution expressed as the percentages by mass passing a specified set of sieves (9).
116. HCR_Motorways-Expressway: This type of roads is High Capacity Roads such as Motorways and Expressways. This class roads is full access controlled or half access controlled double carriageway highways. Full access controlled highways are generally tolled even there are free motorways in some European countries such as Germany and named as autobahn. Not only physical but also geometric capacity of this type of roads is high. The applied speed limits on these roads are also higher.
117. Hot Rolled Asphalt (HRA): Dense, gap graded bituminous mixture in which the mortar of fine aggregate, filler and high viscosity binder are major contributors to the performance of the laid material". Coated chippings (nominally single size aggregate particles with a high resistance to polishing, which are lightly coated with high viscosity binder) are always rolled into and form part of a Hot Rolled Asphalt surface course. This durable surface layer was often used as a surface layer in the United Kingdom of Great Britain and Northern Ireland (10).
118. Implementation year: The year that a project is anticipated to be complete and open to traffic (11).
119. Infrastructure: Basic facilities, services, and installations needed for the functioning of a community or society, including water and sewage systems, lighting, drainage, parks, public buildings, roads and transportation facilities, and utilities (13).
120. Interchange: A grade separation of two or more roads with one or more interconnecting carriageways (14).
121. Intersection: A place at which two or more roads cross at grade or with grade separation (14).
122. Lane line: The lane line is the broken line separating lanes for traffic moving in the same direction or a solid line for delineating traffic lanes and shoulder edge (11).
123. Lane-Km.: Lane-km. is a measure of the total length of travelled pavement surface. Lane-km. is the centerline length (in km.) multiplied by the number of lanes (11).
124. Layer: Element of a pavement laid in a single operation (10).
125. Life Cycle: Consecutive and interlinked stages in the life of the object under consideration (2).
126. Life Cycle Cost - LCC: Cost of a civil engineering works or part of works throughout its life cycle, while fulfilling technical requirements and functional requirements (2).
127. Life-cycle cost analysis: An economic assessment of an item, area, system, or facility and competing design alternatives considering all significant costs of ownership over the economic life, expressed in equivalent dollars (5).
128. Limited access roadway: Limited access roadway is a roadway especially designed for through traffic and over, from, or to which owners or occupants of abutting land or other persons have no right or easement of access by reason of the fact that their property abuts such limited access facility or for any other reason. Interstate highways, parkways, and freeways are usually developed as limited-access facilities (11).
129. Line: A line is a baseline of roadway (11).
130. Local road: A local road is a road that primarily provides access to adjacent land and provides service to motorists over relatively short distances (11).

131. Longitudinal slope: Either a foreslope, which occurs when the roadway is located on a fill and the clear zone slopes down from the roadway, or a backslope, which occurs when the roadway is located on a cut and the clear zone slopes up from the roadway (13).
132. Low-volume road: Low-volume road is a roadway generally subjected to low levels of traffic (11).
133. MCR-Primary Roads: This type of roads is Medium Capacity Roads such as Primary Roads. This class roads are not access controlled roads. They are free of charged roads. The financial source is taxes. They are double or single carriageway of highways. The geometric and physical capacity of this type of roads is medium. They are also main arterials and principal roads of national highways system of countries. The applied speed limits on these roads are lower than HCR.
134. MCR-Secondary Roads: This type of roads is Medium Capacity Roads such as Secondary Roads. This class roads are also not access controlled roads. They are also free of charged roads. The financial source is taxes. They are double or single carriageway of highways. The geometric and physical capacity of this type of roads is also medium but relatively lower than MCR_Primary Roads. They are important connectors of the national highways system to towns, connecting cities to towns also. The applied speed limits on these roads are lower than HCR.
135. Maintenance: The preservation through treatment activities of the entire roadway, including surface, shoulders, roadsides, structures, and such traffic control devices as are necessary for its safe and efficient utilization (5).
136. Maintenance activities: Combination of all technical and associated administrative actions during the service life to retain a civil engineering works or an assembled system (part of works) in a state in which it can perform its required functions. Note 1 to entry: Maintenance includes cleaning, servicing, repainting, repairing, replacing parts of the construction works where needed, or according to approved levels of service. (Construction Products Directive Guidance Paper F). Note 2 to entry: Adapted from the definition in ISO 15686-1, ISO 6707-1 and in Construction Products Directive Guidance Paper F (2).
137. Maintenance cost: Total of necessarily incurred labour, material and other related costs incurred to retain a road or its parts in a state in which it can perform its required functions. Note 1 to entry: Maintenance includes conducting corrective, responsive and preventative maintenance on constructed assets, or their parts, and includes all associated management, cleaning, servicing, repainting, repairing and replacing of parts where needed to allow the constructed asset to be used for its intended purposes (1).
138. Major arterial: Roadway that services state-wide travel as well as major traffic movements within urbanized areas or between suburban centres (high mobility, limited access) (13).
139. Manufactured Aggregate: Aggregate of mineral origin resulting from an industrial process involving thermal or other modification (9).
140. Mastic Asphalt (MA): Voidless asphalt mixtures with bitumen as a binder in which the volume of filler and binder exceeds the volume of the remaining voids in the mixed". This mixture is very durable and was often used as surface layer in certain countries (10).
141. Median: The median is the portion of a divided highway separating the opposing traffic flows. A median may be traversable or no traversable.
142. Modified Bitumen: Bituminous binder whose rheological properties have been modified during manufacture by the use of one or more chemical agents. Note 1 to entry: In this context, "chemical agent" includes natural rubber, synthetic polymers, waxes, sulfur and certain organo-metallic compounds, but not oxygen or oxidation "catalysts" such as

ferric chloride, phosphoric acid and phosphorus pentoxide. Fibres and inorganic powders (“fillers”) are not considered to be bitumen modifiers. Modified bitumens may be employed “directly” or in the form of cut-backs or emulsions, or blended with (for example) natural asphalt (8).

143. Motorway: A defined class of road for which certain activities or uses are restricted or prohibited by legislative provision (14).

144. Multilane highway: A multilane highway is a highway with four or more lanes (11).

145. Natural Asphalt: Naturally occurring mixture of bitumen and finely divided mineral matter which is found in well-defined surface deposits and which is processed to remove unwanted components such as water and vegetable matter (10).

146. Natural Aggregate: Aggregate from mineral sources that has been subjected to nothing more than mechanical processing (9).

147. Net present value: The net value of all present and future costs and benefits converted to a single point in time using a discount rate factor (5).

148. New Bridge Construction: It is a new bridge construction including approaching roads on an existing road alignment or on new road corridor (7).

149. New Construction: There is not any existing road for this kind of project. It is totally new building of a road with all parts; subgrade, pavement, structures, etc. (7).

150. New Tunnel Construction: It is a new tunnel construction on an existing road alignment or on new road corridor (7).

151. Nominal cost: Expected price that will be paid when a cost is due to be paid, including estimated changes in price due to, for example, forecast change in efficiency, inflation or deflation and technology (1).

152. Normal Cost: The most probable cost for a unit or element of the project. The normal cost represents the cost that can most reasonably be expected if no significant problems occur. The normal cost typically has small uncertainty or variance (4).

153. Operation Cost: Costs incurred in running and managing the facility or built environment, including administration support services. Note 1 to entry: Operation costs could include rent, rates, insurances, energy and other environmental/regulatory inspection costs, local taxes and charges (1).

154. Overlay: An overlay is a layer or layers of paving materials placed on an existing surface where repairs to a pavement structure are required to restore a satisfactory riding surface and/or improve the strength of the pavement structure (11).

155. Overpass: A grade separation where a minor highway passes over the major highway (12).

156. Pavement: Pavement is that part of a roadway having a constructed surface for the facilitation of vehicular traffic (11).

157. Pavement Condition: A quantitative representation of pavement distress at a given point in time (5).

158. Pavement crack: A pavement crack is a fissure or open seam in pavement which does not necessarily extend through the body of the pavement material. Pavement cracking includes alligator, longitudinal, and transverse cracking (11).

159. Pavement design: Pavement design includes two tasks: (1) mixture or materials design and (2) structure or thickness design. These two tasks cannot be cleanly separated at

the design stage; there must be interaction between the tasks. Specifications are the link between mixtures and thickness design (11).

160. Pavement distress: Pavement distress is cracking, rutting, distortion or other types of surface deterioration which indicates a decline in the pavement's surface condition or structural load-carrying capacity (11).

161. Pavement management: Pavement management is a method of finding cost-effective strategies for providing, evaluating and maintaining pavements in a serviceable condition (11).

162. Pavement Management System (PMS): The Pavement Management System (PMS) is a set of tools or methods that can assist decision makers in finding cost-effective strategies for providing, evaluating and maintaining pavements in a serviceable condition (11).

163. Pavement Structure: The combination of sub-base, base, paving geotextiles, and surface courses placed on a subgrade to support and distribute the traffic load to the roadbed (3).

164. Pavement Preservation: A program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations (6).

165. Pavement Reconstruction: The replacement of the entire existing pavement structure by the placement of the equivalent or increased pavement structure. Reconstruction usually requires the complete removal and replacement of the existing pavement structure. Reconstruction may utilize either new or recycled materials incorporated into the materials used for the reconstruction of the complete pavement section. Reconstruction is required when a pavement has either failed or has become functionally obsolete (6).

166. Pavement rehabilitation: The act of restoring a pavement to a former condition. It consists of "structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capacity. Rehabilitation techniques include restoration treatments and structural overlays:

- Major rehabilitation "consists of structural enhancements that both extend the service life of an existing pavement and/or improve its load-carrying capability".
- Minor rehabilitation is non-structural enhancements made to the existing pavement sections to eliminate age-related, top-down surface cracking that develops in flexible pavements as a result of environmental exposure (5,6).

167. Pavement Replacement: Renewing of the pavement either by removing the total thickness of all layers of pavement, existing asphalt layers from an existing pavement or not, and providing a new paved surface without changing capacity or geometry of the road, i.e. without changing subgrade (7).

168. Paving Bitumen: Bitumen used to coat aggregate and/or reclaimed asphalt, mainly used in the construction and maintenance of paved surfaces and hydraulic works. Note 1 to entry: In Europe, the most-used grades of paving bitumen are defined by their needle penetration at 25°C, up to a maximum value of 900 x 0,1 mm (8).

169. Pedestrian bridge: Pedestrian bridge is designed for, and intended to carry, primarily pedestrians, bicyclists, equestrian riders and light maintenance vehicles, but not designed and intended to carry typical highway traffic (18).

170. Percent of grade: Percent of grade is the grade of centreline or profile grade road between vertical points of intersection $+0.10\%$ = Increase in elevation by 0.10 feet for each 100 feet station (11).

171. Percent slope (% Slope): Percent slope (% slope) is the change in elevation divided by the horizontal distance over which the change occurs for a vertical line. A perched water table, in hydrology, is the upper surface of a body of free ground water in a zone of saturation, separated by unsaturated material from an underlying body of ground water in a differing zone of saturation (11).
172. Portland cement: Portland cement is a finely powdered substance, usually grey or brownish grey, composed largely of artificial crystalline minerals, the most important of which are calcium and aluminium silicates. The calcium silicate compounds, upon reaction with water, produce the new compounds capable of imparting the stone like quality to the mixture (11).
173. Portland cement concrete pavement: Portland cement concrete pavement is a hardened mixture of Portland cement, aggregate, and water used to pave streets or highways. This mixture may or may not contain steel reinforcing (11).
174. Pre-cast: Pre-cast is concrete that is formed, placed, and cured before being placed in its final position. An example is a pre-cast concrete beam for a bridge (11).
175. Prestressed concrete: Prestressed concrete is precast concrete subject to pretensioning, post-tensioning, or a combination of both (11).
176. Preventive Maintenance: A planned strategy of cost-effective treatments to 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) (5).
177. Pre-stressed simple beam bridge: A type of bridge, simply supported prestressed concrete beams (7).
178. Porous Asphalt (PA): Bituminous material with bitumen as a binder prepared so as to have a very high content of interconnected voids which allow passage of water and air in order to provide the compacted mixture with drain and noise reducing characteristics (10).
179. Project: An undertaking to develop, implement, or construct a particular transportation enhancement at a specific location or locations (4).
180. Project classification: Project classification is an official classification of the type of project provided for in construction (11).
181. Radius: A radius is a line segment extending from the centre of a circle to the curve (11).
182. Real Cost: Cost expressed as a value at the base date, including estimated changes in price due to forecast changes in efficiency and technology, but excluding general price inflation or deflation (1).
183. Reconditioning: Reconditioning includes improvement of grades, curves, intersections or sight distances in order to improve road infrastructure safety or changing the subgrade to widen shoulders or to improve structural capacity in addition to resurfacing or pavement replacement (7).
184. Reconstruction: Total replacement of pavement and subgrade of an existing road. Works include both changing the existing road centerline (vertical and horizontal) at minimum 50 per cent of the project length and replacement all the existing pavement layers. In other words, it is the rebuilding of an existing roads' pavement and subgrade to correct road geometry, to increase road safety, to ease maintenance works and to increase preservation (7).

185. Recycled Aggregate: Aggregate resulting from the processing of inorganic or mineral material previously used in construction. Note 1 to Entry: Recycled aggregates can also be obtained from production residues or nonconforming products, e.g. crushed unused concrete (9).
186. Regulating Course: Course of variable thickness applied to an existing course or surface to provide the necessary profile for a further course of consistent thickness (10).
187. Remaining Service Life: Structural life remaining in the pavement at the end of analysis period (5).
188. Reinforced concrete pavement: Reinforced concrete pavement is Portland concrete pavement in which steel is used to control the width of shrinkage and thermal cracking of the concrete. The steel adds strength to the concrete in tension (11).
189. Residual Value: Value of the in-place pavement materials less the cost to remove and process the materials for reuse (5).
190. Resurfacing: Placing a new surface of an existing road in order to service in good condition, to increase skid resistance, to seal by aiming to preserve road from negative atmospheric conditions, to increase driver comfort, to prolong pavement life, etc. The aim is not to increase the bearing capacity of pavement but to prolong service life (7).
191. Resurfacing by Strengthening: Renewing of road surface with paving bituminous layers either by directly or by removing calculated depth of pavement to eliminate road deterioration in order to increase bearing capacity of road (7).
192. Right of Way (ROW):
- (a) Right of way is a general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to transportation purposes.
 - (b) Right of way is a general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to a highway for the construction of the roadway. Right of way is the entire width of land between the public boundaries or property lines of a highway. This may include purchase for drainage (14).
193. Rigid pavement: A pavement structure which distributes loads to the subgrade, having as one course a Portland cement concrete slab of relatively high-bending resistance (11).
194. Risk: The potential impact of an uncertain condition or action on project objectives and outcomes (5).
195. Risk allocation: The process of allocating contractual obligations and risks between parties (5).
196. Restoration:
- (a) Restoration: The act or process of accurately recovering the form and details of a property and its setting as it appeared at a particular period of time by means of the removal of later work or by the replacement of missing earlier work (4).
 - (b) Restoration: The repair and/or replacement of specific lost functions within a natural system, such as habitat, water buffers, and soil function (13).
197. Road: A route trafficable by motor vehicles. In law, the public right-of-way between boundaries of adjoining property and is owned or administrated by a road authority (14).
198. Roadbed: The graded portion of a highway prepared as a foundation for the pavement structure and shoulders (3).

199. Roadside: A general term denoting the area beyond the shoulder breakpoints (12).
200. Road infrastructure: the infrastructure which forms part of a roadway, pathway or shoulder, including:
- structures forming part of the roadway, pathway or shoulder,
 - materials from which a roadway, pathway or shoulder is made (7).
201. Road tunnel: A road tunnel is a tunnel constructed for the purpose of building an underground road (7).
202. Roadway:
- (a) Roadway is the portion of the highway within the limits of construction.
 - (b) Roadway is that portion of a highway improved, designed, or ordinarily used for vehicular travel, exclusive of the berm or shoulder. In the event a highway includes two or more separate roadways, the term “roadway” as used in the Equipment Manual shall refer to such roadway separately, but not to all such roadway collectively (11).
203. Roadway alignment: The vertical and horizontal location of a road (13).
204. Roadway improvement: A roadway improvement is construction or reconstruction made to the roadway cross-section (11).
205. Rolling terrain: The natural slopes consistently rise above and fall below the highway grade with, occasionally, steep slopes presenting some restrictions on highway alignment. In general, rolling terrain generates steeper gradients, causing truck speeds to be lower than those of passenger cars (12).
206. Routine Maintenance: Consists of work that is planned and performed on a routine basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service (6).
207. Periodic Maintenance [to be completed].
208. Rural: Refers to areas with large expanses of undeveloped or agricultural land, dotted by small towns, villages, or any other small activity clusters (13).
209. Rural road: A rural road is a road, street, way, highway, thoroughfare, or bridge that is located in an unincorporated area and that is not privately owned or controlled, any part of which is open to the public for vehicular traffic, and over which the state or any of its political subdivisions have jurisdiction (11).
210. Rural road or highway: Characterized by low volume high-speed flows over extended distances. Usually without significant daily peaking but could display heavy seasonal peak flows (12).
211. Salvage Value: The value (positive if a residual economic value is realized and negative if demolition costs are accrued) of competing alternatives at the end of the life cycle or analysis period. [It] typically consists of remaining service life and residual value (5).
212. Seal coat: Seal coat is an asphaltic coating, with aggregate, applied to the surface of a pavement structure for the purpose of waterproofing and preserving the surface, reconditioning a previous asphaltic surface treatment, improving the surface texture of the wearing surface, changing the surface colour or providing resistance to traffic abrasion (11).

213. Service life: The period of time from completion of construction until the structural integrity of the pavement is determined to be unacceptable and rehabilitation/replacement is required (Hallin et al. 2011) (5).
214. Shoulder: Shoulders are the portion of the roadway adjacent to the travelled way (on either side) for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface (11).
215. Shoulder breakpoint: The hypothetical point at which the slope of the shoulder intersects the line of the fill slope. Sometimes referred to as the hinge point (12).
216. Soft Asphalt (SA): Mixture of aggregate and soft bitumen grades". This flexible mixture is used in the Nordic countries for secondary roads (10).
217. Shoulder drains: Shoulder Drains refer to erosion control riprap concrete drains usually used to drain runoff from bridge embankment areas (11).
218. Shoulder hinge point: In the cross-section of a road, the point at which the side slope would intersect with the unsealed shoulder, or in the absence of an unsealed shoulder, the sealed shoulder (14).
219. Sidewalk: The portion of the cross-section reserved for the use of pedestrians (12).
220. Sight distance: The distance measured along the carriageway over which objects of defined height are visible to a driver (14).
221. Single tube road tunnel: Traffic normally flows in two directions through the single tube that is bi-directional flow (7).
222. Skid resistance: The skid resistance of a road surface indicates the capacity to convey friction in the contact area between tyre and road surface. Skid resistance is necessary to offset the horizontal forces that occur in the contact area between tyre and road surface during vehicle movements (accelerating, braking and steering). In order to be able to drive safely on a road it is important for a road surface to have adequate skid resistance in both wet and dry conditions (15).
223. Stone Mastic Asphalt (SMA): Gap-graded asphalt mixture with bitumen as a binder, composed of a coarse crushed aggregate skeleton bound with a mastic mortar". This mixture is often used as a surface layer in case high stability is needed. The surface structure also has good noise reducing properties (10).
224. Subbase: Subbase is the layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course (or in the case of rigid pavements, the Portland cement concrete slab). The layer used in the pavement system between the subgrade and the base course (11).
225. Subgrade: The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed and extending to such depth as will affect the structural design (3, 17).
226. Substructure: Substructure is that part of a bridge structure covered on bent details, or below the bridge seats including back walls and wing walls at abutments (11).
227. Sunk costs: Costs of goods and services already incurred and/or irrevocably committed. Note 1 to entry: These are ignored in an appraisal. The opportunity costs of obtaining or continuing to tie up capital are, however, included in WLC analysis and the opportunity costs of using assets can be dealt with as costs in LCC analysis (1).
228. Superelevation: Superelevation refers to the method of banking the roadway by attaining a vertical difference between the inner and outer edges of pavement (11).

229. **Superelevation rate:** A superelevation rate is the rate of rise in cross section of the finished surface or a roadway on a curve, measured from the lowest edge to the highest edge (11).
230. **Superstructure:** A superstructure is that part of a bridge structure covered on the span details, or above the bridge seats (11).
231. **Surface Course:** The top layer or layers of a pavement structure designed to accommodate the traffic load and resist skidding, traffic abrasion, and weathering (3).
232. **Surface treatment:** An application of bituminous material followed by a layer of mineral aggregate. Multiple applications of bituminous material and mineral aggregate may be used (16).
233. **Suspension bridge:** A suspension bridge is a type of bridge in which the deck (the load-bearing portion) is hung below suspension cables on vertical suspenders (7).
234. **Technical Performance:** Performance related to the capability of construction works or an assembled system (part of works), which are required or are a consequence of the requirements made either by the client, users and/or by regulations (2).
235. **Technical Requirement:** Type and level of technical characteristics of a construction works or an assembled system (part of works), which are required or are a consequence of the requirements made by the client, users and/or by regulations (2).
236. **Terrain:** Physical features of a tract of land (13).
237. **Toll road:** A toll road is a highway open to traffic only upon payment of a direct fee (11).
238. **Topography:** Topography is the details of a surface, including natural and man-made structures, on a map or chart (11).
239. **Traffic lane:** Traffic lane is the strip of roadway intended to accommodate the forward movement of a single line of vehicles (11).
240. **Travel lane:** Portion of a roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes (13).
241. **Travelled way:** Travelled way is the portion of the roadway for the movement of vehicles, excluding shoulders and auxiliary lanes (11).
242. **Two-tube tunnel (twin tube tunnel):** Can operate with traffic flowing in one direction through each tube that is uni-directional flow (7).
243. **Underpass:** A grade separation where the subject highway passes under an intersecting highway (12).
244. **Underwater tunnel:** A tunnel which is partly or wholly constructed under a body of water. They are often used where building a bridge or operating a ferry link is impossible, or to provide competition or relief for existing bridges or ferry links (7).
245. **Urban:** Refers to central business districts, residential districts and open space parks typical of larger cities (13).
246. **Vertical curve:** Vertical curve is a parabolic curve drawn tangent to two intersecting grade lines to provide a smooth transition from one grade to another (11).
247. **Viaduct:** Elevated roadway span over a valley, floodplain, wetland, or gorge which provides unrestricted wildlife movements or passage of other activity (13).
248. **Whole-Life Cost:** All significant and relevant initial and future costs and benefits of an asset, throughout its life cycle, while fulfilling the performance requirements (1).

249. Whole-Life Costing: Methodology for systematic economic consideration of all whole-life costs and benefits over a period of analysis, as defined in the agreed scope. Note 1 to entry: The projected costs or benefits may include external costs (including, for example, finance, business costs, income from land sale, user costs). Note 2 to entry: Whole-life costing can address a period of analysis that covers the entire life cycle or (a) selected stage(s) or periods of interest thereof. Note 3 to entry: This definition should be contrasted with that for life-cycle costing (1).

III. References

- (1) Draft international standard ISO/DIS 15686-5.2, (Buildings and constructed assets - Service-life planning Part 5: Life-cycle costing), 2016.
- (2) Sustainability of construction works - Sustainability assessment of buildings and civil engineering works - Part 5: Framework for the assessment of sustainability performance of civil engineering works, European standard prEN 15643-5, 2016.
- (3) Standard specifications for construction of roads and bridges on federal highway projects FP - 14, United States Department of Transportation, Federal Highway Administration (Section 101), 2014.
- (4) NCHRP report 574 (National Cooperative Highway Research Program), Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction, 2007.
- (5) NCHRP synthesis 499 (National Cooperative Highway Research Program), Alternate Design/Alternate Bid Process for Pavement-Type Selection, A Synthesis of Highway Practice, 2017.
- (6) Memo: Pavement Preservation Definitions - Pavement Preservation - Design & Analysis - Pavements - Federal Highway Administration.
- (7) General directorate of Turkish highways definition.
- (8) Bitumen and bituminous binders - Terminology, EN 12597, May 2014.
- (9) Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas, EN 13043, 2016.
- (10) Bituminous mixtures - Material specifications - Part 1-9, EN 13108 series (1-9), 2016.
- (11) TxDOT Glossary, Texas Department of Transportation, 2013.
- (12) Geometric Design Guidelines, South African National Roads Agency Limited.
- (13) MassHighway Glossary, 2006.
- (14) State Highway Geometric Design Manual, Glossary of Terms, Transit New Zealand, 2005.
- (15) Skid Resistance on National Roads, Ministry of Infrastructure and the Environment, Rijkswaterstaat Major Projects and Maintenance, June 2017.
- (16) ASTM D8, Standard Terminology Relating to Materials for Roads and Pavements.
- (17) AASHTO M 146, Standard Specification for Terms Relating to Subgrade, Soil-Aggregate, and Fill Materials.
- (18) NCHRP 20-07, TASK 244 LRFD Guide Specifications for The Design Of Pedestrian Bridges.