Designation: E2103/E2103M – 19

Standard Classification for Bridge Elements—UNIFORMAT II[1]

This standard is issued under the fixed designation E2103/E2103M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard establishes a classification of bridge elements within the UNIFORMAT II family of elemental classifications. It covers most highway bridges, railroad bridges, and pedestrian bridges.

1.2 UNIFORMAT II classifications have an elemental format similar to the original UNIFORMAT[2] building elemental classification. However, the title UNIFORMAT II differs from the original in that it now takes into consideration a wide range of constructed entities that collectively form the built environment.

1.3 Elements, as defined here and in other UNIFORMAT II Classifications, are major physical components that are common within constructed entities. Elements perform their given function(s), regardless of the design specification, construction method, or materials used.

1.4 This elemental classification serves as a consistent reference for analysis, evaluation, and monitoring during the feasibility, planning, and design stages when constructing bridges.

1.5 Using UNIFORMAT II elemental classifications ensures a consistency in the economic evaluation of construction projects over time and from project to project.

1.6 UNIFORMAT II classifications also enhance reporting at all stages of a constructed entity's life cycle—from feasibility and planning through the preparation of working documents, construction, maintenance, rehabilitation, and disposal.

1.7 This classification is unsuitable for process applications or for preparing trade estimates.

1.8 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E631 Terminology of Building Constructions

E833 Terminology of Building Economics

E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems

E964 Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems

E1057 Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems

E1074 Practice for Measuring Net Benefits and Net Savings for Investments in Buildings and Building Systems

E1121 Practice for Measuring Payback for Investments in Buildings and Building Systems

E1185 Guide for Selecting Economic Methods for Evaluating Investments in Buildings and Building Systems

E1369 Guide for Selecting Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Buildings and Building Systems

E1699 Practice for Performing Value Engineering (VE)/Value Analysis (VA) of Projects, Products and Processes

E1804 Practice for Performing and Reporting Cost Analysis During the Design Phase of a Project

[1] This classification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.81 on Building Economics.

Current edition approved July 1, 2019. Published September 2019. Originally approved in 2000. Last previous edition approved in 2013 as E2103/E2103M–13. DOI: 10.1520/E2103_E2103M–19.

[2] The original UNIFORMAT classification was developed jointly by the General Services Administration (GSA) and the American Institute of Architects (AIA).

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E1946 Practice for Measuring Cost Risk of Buildings and Building Systems and Other Constructed Projects
E2013 Practice for Constructing FAST Diagrams and Performing Function Analysis During Value Analysis Study
E2506 Guide for Developing a Cost-Effective Risk Mitigation Plan for New and Existing Constructed Facilities
E2691 Practice for Job Productivity Measurement

2.1.1 *ASTM UNIFORMAT II Classification Standards Family:* [3]

E1557 Classification for Building Elements and Related Sitework—UNIFORMAT II
E2083 Classification for Building Construction Field Requirements, and Office Overhead & Profit
E2168 Classification for Allowance, Contingency, and Reserve Sums in Building Construction Estimating
E2514 Practice for Presentation Format of Elemental Cost Estimates, Summaries, and Analyses
E2516 Classification for Cost Estimate Classification System

2.2 *ASTM Adjuncts:*[4]

Adjunct to E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems - Includes Excel and PDF Files

3. Terminology

3.1 *Definitions*—For definitions of general terms related to building construction used in this classification, refer to Terminology E631, and for general terms related to building economics, refer to Terminology E833.

4. Significance and Use

4.1 This classification builds on the concepts and organizational framework first established in Classification E1557. This classification describes bridge elements that are major components of most highway, railroad, and pedestrian bridges. The elemental classification is the common thread linking activities and participants in a bridge project from initial planning through operations, maintenance, and disposal.

NOTE 1—As this classification refers solely to permanent, physical parts of any construction, two additional classifications, Classifications E2083 and E2168, need to be included when calculating construction cost. These standards provide for the inclusion of construction enabling, temporary, and risk mitigation cost figures. Procedures for reporting all these figures are described in Practices E1804 and E2514 and Classification E2516. While these three latter standards were primarily written for building construction, they are nonetheless appropriate and readily applied to other forms of construction as well.

4.2 *The Users of Bridge UNIFORMAT II Include:*

4.2.1 *Financial and Investment*—Typically owners, developers, bankers, lenders, accountants, and financial managers.

4.2.2 *Implementation*—Primarily project managers; facilities programmers; designers, including engineers; and project controls specialists, including cost planners, estimators, schedulers, specification writers, and risk analysts.

4.2.3 *Facilities Management*—Comprising property portfolio managers, operating staff, and maintenance staff.

4.2.4 *Others*—Public officials, manufacturers, educators, students, and other project stakeholders.

4.3 *Apply This Classification When Undertaking the Following Work on Bridges:*[5]

4.3.1 *Financing and Investing:*

4.3.1.1 Structuring costs on an elemental basis for economic evaluations (Guide E1185 and Practices E917, E964, E1057, E1074, E1121, and E1804) early in the design process helps reduce the cost of early financial analysis and can contribute to substantial design and operational savings before decisions have been made that limit options for potential savings.

4.3.2 *Implementing:*

4.3.2.1 *Cost Modeling, Cost Planning, Estimating and Controlling Project Time and Cost During Planning, Design, and Construction*—Use the bridge UNIFORMAT II classification to prepare budgets and to establish elemental cost plans before design begins. Project managers and project controls specialists use these cost plans against which to measure and control project cost, and quality, and to set design-to-cost targets.

4.3.2.2 Conducting Value Engineering Workshops—Conducting value engineering workshops (Practices E1699 and E2013). Use this classification as a checklist to ensure that alternatives for all elements of significant cost in the bridge project are analyzed in the creativity phase of the job plan. Also, use the elemental cost data to expedite the development of cost models for bridge systems.

4.3.2.3 *Developing Initial Project Master Schedules*—Since projects are essentially built element by element, UNIFORMAT II classifications are an appropriate basis for preparing construction schedules at the start of the design process. Project managers and project controls specialists use these time plans against which to measure and control project time (Practice E2691), and to set milestone target dates.

4.3.2.4 Performing Risk Analyses—Simulation (Guides E1369 and E2506) is one technique for developing probability distributions of bridge costs when evaluating the economic risk in undertaking a bridge project. Use individual elements and group elements in this classification for developing probability distributions of elemental costs. From these distributions, build up probability distributions of total costs to establish project contingencies (Practice E1946 and Classification E2168) or to serve as inputs to an economic analysis.

4.3.2.5 *Structuring Preliminary Project Descriptions During the Conceptual Design Phase*—This classification facilitates the description of the scope of the project in a clear, concise, and logical sequence for presentation to the client; it provides the basis for the preparation of more detailed elemental estimates during the early concept and preliminary design

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJE091717-EA. Original adjunct produced in 1984. Adjunct last revised in 2017.

[5] For a more comprehensive discussion of the uses of UNIFORMAT II, see Bowen, Charette, and Marshall, *UNIFORMAT II—A Recommended Classification for Building Elements and Related Sitework*, National Institute of Standards and Technology Special Publication 841, Gaithersburg, MD, 1992; and Charette and Marshall, *UNIFORMAT II Elemental Classification for Building Specifications, Cost Estimating, and Cost Analysis*, National Institute of Standards and Technology NISTIR 6389, Gaithersburg, MD, 1999.

phases, and it enhances communication between designers and clients by providing a clear statement of the designer's intent.

4.3.2.6 *Coding and Referencing Standard Details In Computer-Aided Design Systems*—This classification allows a designer, for example, to reference an assembly according to this classification's element designations and build up a database of standard details. This is particularly appropriate to design modeling and building information modeling (BIM) applications.

4.3.3 *Managing Facilities:*

4.3.3.1 Recording and writing property condition assessment reports in a structured way, using UNIFORMAT II classifications, provides for a consistent, accessible, and searchable database of real property inventory.

4.3.4 *Other Activities:*

4.3.4.1 Structuring cost manuals and recording construction, operating, and maintenance costs in a computer database. Having a cost manual or computer database in an elemental format assists the preparation of an economic analysis early in the design stage and at a reasonable cost.

5. Basis of Classification

5.1 The framework in Fig. 1 shows the various constructed entities that collectively are used to create the built environment. Each entity is treated as a module. Appropriate modules used together will effectively describe any planned or built development. This standard classification describes exclusively the elements that make up one of those constructed entities, bridge structures, shown as the shaded block under the heading of Heavy (Civil) Entities.

5.1.1 This bridge classification is applicable to most types of highway, railroad, and pedestrian bridges crossing over highways, railroads, walkways, and waterways. The classification includes slab bridges; beam/girder bridges; truss bridges; true and tied-arch bridges; cable-stayed bridges; and suspension bridges. The classification does not include the following movable bridge types: draw bridges; lift bridges; and bascule bridges.

5.2 The classification is consistent with typical costing practices used at the conceptual design phase.

5.3 Each element has a significant impact on the cost, and it usually occurs frequently.

5.4 Each element performs a specific function.

5.5 Table 1 divides the classification of bridge elements into three hierarchical levels: Level 1—Major Group Elements, Level 2—Group Elements, and Level 3—Individual Elements. The major groups are listed in the normal chronological order of construction.

5.6 Sub-Classifications are named Sub-Elements and comprise as many hierarchical levels (Level 4 and below) as are deemed appropriate to the needs of that specific example. Appendix X1 provides an example Sub-Classification of bridge elements.

5.7 The decision as to where among the classification elements to include specific construction items will rely on professional judgment as to where professionals in current practice normally look for such items.

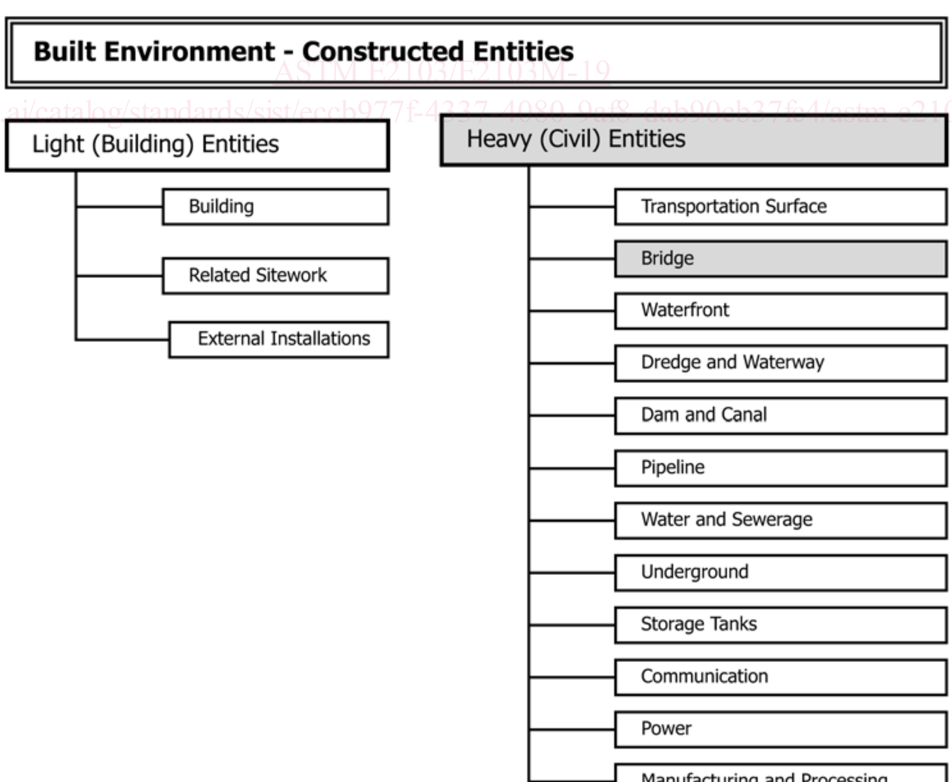

FIG. 1 List of Constructed Entities Suitable for Inclusion in the Family of UNIFORMAT II Elemental Classifications

TABLE 1 UNIFORMAT II Classification of Bridge Elements

Level 1 Major Group Elements	Level 2 Group Elements	Level 3 Individual Elements
A Substructure	A10 Piers	A1010 Foundations
		A1020 Walls
		A1030 Columns
		A1040 Cap Beams
	A20 Towers	A2010 Foundations
		A2020 Walls
		A2030 Columns
		A2040 Cap Beams
	A30 Abutments	A3010 Foundations
		A3020 Stems
		A3030 Wing Walls
	A40 Other Supports	A4010 Thrust Blocks
		A4020 Anchorages
B Superstructure	B10 Short Span Assemblies	B1010 Flexural Members
		B1020 Diaphragms
		B1030 Bracings
		B1040 Bearings
	B20 Long Span Assemblies	B2010 Ribs
		B2020 Cables
		B2030 Hangers
		B2040 Spandrels
		B2050 Ties
		B2060 Truss Members
		B2070 Segmental Box Girders
	B30 Deck	B3010 Structural Surface
		B3020 Wearing Surface
C Protection	C10 Structure Protection	C1010 Slope Walls
		C1020 Expansion Joints
		C1030 Protective Coats
		C1040 Sacrificial Beams
		C1050 Drainage Systems
		C1060 Inspection and Maintenance Systems
	C20 Traffic Protection	C2010 Barriers
		C2020 Protective Shields
		C2030 Traffic Controls
	C30 Other Protection	C3010 Lighting
		C3020 Signage
		C3030 Sound Barrier Walls
		C3040 Air Pressure Barriers
		C3050 Enclosure
D Sitework	D10 Site Preparation	D1010 Clearing and Grubbing
		D1020 Demolition and Relocation
		D1030 Earthwork
		D1040 Hazardous Material Handling
		D1050 Environmental Restoration/ Replacement
	D20 Approach Construction	D2010 Approach Slabs
		D2020 Sleeper Slabs
		D2030 Earth Retention Systems

5.8 Only items that impact the choice and cost of the bridge elements are included. Other civil works in the transportation system are not included. Consequently, this classification does not include utilities—pipelines (water, natural gas, and petroleum) and transmission lines (electrical, communication, and video)—sharing the same right of way as the transportation system.

5.9 Elements, as used and defined in UNIFORMAT II, will ideally display the following additional attributes:

5.9.1 Capable of being defined precisely;

5.9.2 Self explanatory;

5.9.3 Separable at all stages of development;

5.9.4 Quantifiable at all stages of development;

5.9.5 Capable of reconciliation with other elemental classifications;

5.9.6 Allow comparisons, project to project, in a meaningful way;

5.9.7 Is a functional component of the constructed entity.

5.10 Sitework elements are provided for exclusive use in support of the construction of bridges, not to classify elements of major civil construction works. Sitework elements presented in Table 1 are designed to provide sufficient detail to planners so they will not need to resort to other elemental classifications when working on a bridge project.

6. Description of Bridge Elements

6.1 *Elements*—Table 2 provides, for each Level 3 Individual Element, the name, description, inclusions, exclusions, and unit of measure.

TABLE 2 Description of UNIFORMAT II Bridge Elements

A SUBSTRUCTURE	
A10 Piers	
	A1010 Foundations
Description	Foundations are structures that transfer the load of the bridge substructures to the ground. They may be spread footings, piles, or drilled shafts. The type depends upon the soil conditions.
Includes	Excavation and backfilling
Excludes	
Unit of Measure	m^3 [yd^3] or m [ft]
	A1020 Walls
Description	Walls are structures that support the columns; in addition to transferring the load from the columns to the foundation, they protect the pier against impacts from vehicles, vessels, and debris.
Includes	
Excludes	
Unit of Measure	m^3 [yd^3] or kg [lb]
	A1030 Columns
Description	Columns are structures that support the cap beam and transfer the load from the cap beam to the wall below.
Includes	
Excludes	
Unit of Measure	m^3 [yd^3] or kg [lb]
	A1040 Cap Beams
Description	Cap beams are structures that receive and transfer beam loads from the deck to the bridge columns.
Includes	Bridge seat
Excludes	Bearings and anchor bolts (see Bearings, Flexural Members)
Unit of Measure	m^3 [yd^3] or kg [lb]
A SUBSTRUCTURE	
A20 Towers	
	A2010 Foundations
Description	Foundations are structures that transfer the load of the bridge substructures to the ground. They may be spread footings, piles, or drilled shafts. The type depends upon the soil conditions.
Includes	Excavation and backfilling
Excludes	
Unit of Measure	m^3 [yd^3] or m [ft]
	A2020 Walls
Description	Walls are structures that support the columns; in addition to transferring the load from the columns to the foundation, they protect the pier against impacts from vehicles, vessels, and debris.
Includes	
Excludes	
Unit of Measure	m^3 [yd^3] or kg [lb]
	A2030 Columns
Description	Columns are structures that support the cap beam and transfer the load from the cap beam to the wall below.
Includes	
Excludes	
Unit of Measure	m^3 [yd^3] or kg [lb]
	A2040 Cap Beams
Description	Cap beams are structures that receive and transfer beam loads from the deck to the bridge columns.
Includes	Bridge seat
Excludes	Bearings and anchor bolts (see Bearings, Flexural Members)
Unit of Measure	m^3 [yd^3] or kg [lb]
A SUBSTRUCTURE	
A30 Abutments	
	A3010 Foundations
Description	Foundations are structures that transfer the load of the bridge substructures to the ground. They may be spread footings, piles, or drilled shafts. The type depends upon the soil conditions.
Includes	Excavation and backfilling
Excludes	
Unit of Measure	m^3 [yd^3] or m [ft]
	A3020 Stems
Description	Stems are usually supported on piles; they partially or fully retain earth behind, support the ends of the first and last spans of the bridge, and support the approach slab.
Includes	Bridge seat, reinforcing, concrete, and finishing
Excludes	Slope wall, foundation, and anchor bolts and bearings (see Foundations, Barriers, Slope Wall, Bearings)
Unit of Measure	m^3 [yd^3] or kg [lb]
	A3030 Wing Walls
Description	Wing walls (parallel, perpendicular, or angled) are structures connected to the abutment and supported by piles that retain the embankment below the approach road.
Includes	Reinforcing, concrete, and finishing
Excludes	Approach slab and parapet (see Approach Slab, Barriers)
Unit of Measure	m^3 [yd^3]
A SUBSTRUCTURE	
A40 Other Supports	
	A4010 Thrust Blocks
Description	Thrust blocks are a special substructure of a true arch bridge that receive loads from the ribs and transfer loads to the foundation.
Includes	Structure excavation, reinforcing, concrete, and finishing
Excludes	Furnishing and installation of anchor bolts, bearing plates, utility relocation (see Demolition and Relocation, Flexural Members)
Unit of Measure	m^3 [yd^3]
	A4020 Anchorages
Description	Anchorages are a special substructure to which the weight of the deck and supporting superstructure is secured via cables and steel eye bars imbedded in solid rock or massive concrete blocks.
Includes	Structure excavation, reinforcing, concrete, finishing, and cable support (Steel Eye Bar)
Excludes	
Unit of Measure	m^3 [yd^3]
B SUPERSTRUCTURE	
B10 Short Span Assemblies	
	B1010 Flexural Members
Description	Flexural members are commonly known as beams and girders that support the bridge deck. When the depth of the girder is shallow, it is referred to as a beam.
Includes	Fabrication and installation of beams and girders
Excludes	Diaphragms, bracings, bearings (see Diaphragms, Bracings, Bearings)
Unit of Measure	kg [lb] or m [ft]
	B1020 Diaphragms
Description	Diaphragms are braces for shallow-depth beams.
Includes	
Excludes	
Unit of Measure	kg [lb] or m^3 [yd^3]
	B1030 Bracings
Description	Bracings are steel angles used to brace deep-depth girders.
Includes	Fabrication and erection of structural steel angles
Excludes	
Unit of Measure	kg [lb]
	B1040 Bearings
Description	Bearings are mechanical systems that transfer vertical and longitudinal forces; expansion bearings allow rotational and longitudinal movement, whereas fixed bearings allow only rotational movement.
Includes	Fabrication and erection of bearings and anchor bolts
Excludes	Bridge seat (see Cap Beams, Stem Abutments)
Unit of Measure	EACH
B SUPERSTRUCTURE	
B20 Long Span Assemblies	
	B2010 Ribs
Description	Ribs are rectangular-, square-, or circular-shaped parts of the superstructure for arch bridges; they receive loads from hangers and spandrels and transfer them to the foundation.

TABLE 2 *Continued*

Includes	
Excludes	Bracings, bearings (see Bracings, Bearings)
Unit of Measure	kg [lb], or m^3 [yd^3], or m [ft]
	B2020 Cables
Description	Cables, made of steel wires bound together and draped over towers to anchors at each cable end, receive through hangars the load from the deck.
Includes	Fabrication and installation of cables, cable support
Excludes	Anchorage (see Anchorage)
Unit of Measure	m [ft]
	B2030 Hangers
Description	Hangers are rods or strands that connect the deck to the ribs (arch bridges) or the main cable (cable-stayed or suspension bridges); they receive loads from the deck and transfer loads to the ribs or main cable in tension.
Includes	Splices (rod), strand assembly, protection
Excludes	End connections (see Flexural Members and Ribs)
Unit of Measure	m [ft]
	B2040 Spandrels
Description	Spandrels are concrete or steel members that connect the deck to the ribs (arch bridges); they receive loads from the deck and transfer loads to the ribs in compression. They are below the deck and above the rib.
Includes	Concrete or steel members, protection
Excludes	End connections (see Flexural Members and Ribs)
Unit of Measure	m [ft]
	B2050 Ties
Description	A tie is a horizontal tension member that connects the two ends of the compression ribs of an arch bridge and balances the horizontal thrust.
Includes	Fabrication and erection of structural steel, stiffeners, splices, and other connections
Excludes	Hangers, bearings (see Bearings, Hangers and Spandrels)
Unit of Measure	kg [lb]
	B2060 Truss Members
Description	Truss members, connected at nodes by plates, are two-dimensional structures that support the superstructure.
Includes	Splices and other connections
Excludes	Bracings, bearings (see Bracings, Bearings)
Unit of Measure	kg [lb], or m^3 [yd^3], or m [ft]
	B2070 Segmental Box Girders
Description	Segmental box girders are concrete box sections with or without overhanging flanges. The segments are precast sections which are post tensioned in the field.
Includes	Post tensioning
Excludes	Bracings, bearings (see Bracings, Bearings)
Unit of Measure	m [ft]
B SUPERSTRUCTURE	
B30 Deck	
	B3010 Structural Surface
Description	The structural surface supports the wearing surface and traffic.
Includes	Reinforcing, concrete, and finishing
Excludes	Expansion joint assembly, parapet, barriers (see Expansion Joints, Barriers, Drainage Systems)
Unit of Measure	m^3 [yd^3] or EACH
	B3020 Wearing Surface
Description	The wearing surface is the part of the road or rail system that comes into contact with the vehicle or train car wheels.
Includes	Concrete or asphalt overlay or rails, striping, marking,
Excludes	
Unit of Measure	m^2 [yd^2]
C PROTECTION	
C10 Structure Protection	
	C1010 Slope Walls
Description	Slope walls, made of stone, concrete, gravel, or gravel with asphalt mix, support the sloped surface and protect the bridge abutment.
Includes	Reinforcing, concrete, and finishing
Excludes	Excavation and backfill (see Earthwork)
Unit of Measure	m^2 [yd^2]
	C1020 Expansion Joints

TABLE 2 *Continued*

Description	Expansion joints allow expansion and contraction of the slab while keeping the substructure stationary.
Includes	Furnishing and installation of expansion joint support and expansion joint
Excludes	
Unit of Measure	m [ft]
	C1030 Protective Coats
Description	Protective coats are paints, sealants, or preservatives that are applied to concrete surfaces of the bridge.
Includes	Minor repair work, cleaning surface, and coating
Excludes	Major repair work to other bridge elements
Unit of Measure	m^2 [yd^2]
	C1040 Sacrificial Beams
Description	Sacrificial beams have a lower clearance than the main beams to ensure that excessive-height vehicles will hit the sacrificial beam before impacting the main beams.
Includes	Fabrication and erection of structural steel, stiffeners, splices, and other connections
Excludes	Bracings, bearings (see Bracings, Bearings)
Unit of Measure	kg [lb]
	C1050 Drainage Systems
Description	Drainage systems are scuppers to drain the bridge deck, downspouts to carry off the water from the scuppers, and buried drains behind abutments and adjacent to sleeper slabs.
Includes	Fabrication and installation of scuppers, drain tiles, drain pipes, and related earthwork
Excludes	Structural surface (see Structural Surface)
Unit of Measure	EACH or m [ft]
	C1060 Inspection and Maintenance Systems
Description	These systems include platforms, railings, stairways, and hoist ways to facilitate inspection and maintenance.
Includes	Handrails or other type of barriers
Excludes	
Unit of Measure	m^2 [yd^2]
C PROTECTION	
C20 Traffic Protection	
	C2010 Barriers
Description	Barriers are structures designed to: withstand forces due to crashes; separate the opposing traffic; and protect bridge structures adjacent to live traffic.
Includes	Noise wall support, or light pole support
Excludes	
Unit of Measure	m^3 [yd^3]
	C2020 Protective Shields
Description	Protective shields are barriers below the bridge deck to protect traffic below from falling objects.
Includes	Membranes and supports designed to catch falling objects
Excludes	
Unit of Measure	m^2 [yd^2]
	C2030 Traffic Controls
Primary Function	Manage Traffic
Secondary Function	
Tertiary Function	
Description	Traffic controls are an assembly of signals, supports, and conduits.
Includes	Power source and related items
Excludes	
Unit of Measure	EACH
C PROTECTION	
C30 Other Protection	
	C3010 Lighting
Description	Lighting is illumination from fixtures that provide vehicle traffic direction, ship navigation direction, task lighting, and vandalism discouragement.
Includes	Fabrication and installation of mast, lights, base plates, and power
Excludes	Base support (see Barriers)
Unit of Measure	EACH
	C3020 Signage
Description	Signage is the provision of information through electronic or printed message boards.
Includes	Fabrication and installation of sign and support, and power

TABLE 2 *Continued*

Excludes	
Unit of Measure	EACH
	C3030 Sound Barrier Walls
Description	A sound barrier wall is a structure to mask traffic noise from the surrounding neighborhood.
Includes	Wall panel, support, and connection to barrier
Excludes	Base (see Barriers)
Unit of Measure	m^2 [yd^2]
	C3040 Air Pressure Barriers
Description	Air pressure barriers are structures to mitigate the impact of significant air pressure differentials created by the passing of high speed transportation vehicles.
Includes	Barriers mounted on bridges to mitigate the impact of air pressure differentials.
Excludes	Base (see Barriers)
Unit of Measure	m^2 [yd^2]
	C3050 Enclosure
Description	An enclosure is a vertical envelope with roof to protect pedestrians and traffic crossing over a bridge.
Includes	Structural and architectural members to contain pedestrians and traffic with expansion joints at the ends
Excludes	
Unit of Measure	m^2 [yd^2]
D SITEWORK	
D10 Site Preparation	
	D1010 Clearing and Grubbing
Description	Clearing is the removal from the construction site of trees and abandoned utilities, and the grading and leveling of the site. Grubbing is the removal of stumps and tree roots.
Includes	Tree removal, abandoned utilities, minor earthwork
Excludes	Major earth work and major utility removal (see Demolition and Relocation, Earthwork)
Unit of Measure	EACH or Hectare (Acre)
	D1020 Demolition and Relocation
Description	Demolition is the complete or partial (for example, deck or superstructure) removal of an existing bridge, carried out on the whole bridge at once or by removing a portion of the deck or superstructure in stages to maintain traffic; relocation is the removal and reinstallation of utilities.
Includes	Removal of bridge elements and disposal, relocation of utilities such as storm sewer
Excludes	
Unit of Measure	EACH
	D1030 Earthwork
Description	Earthwork is excavation, placement, and compaction of material to raise the bridge profile (material is hauled in and compacted) and to lower the bridge profile (material is excavated and hauled away).
Includes	Shrinkage factor for embankment, hauling material to or from the site
Excludes	Removal of hazardous material, structure excavation and back fill (see Demolition and Relocation, Foundations)
Unit of Measure	m^3 [yd^3]
	D1040 Hazardous Material Handling
Description	Hazardous material handling is the discovery, excavation, recovery, and disposal of hazardous materials.
Includes	Excavation and disposal of material
Excludes	General excavation (see Demolition and Relocation, Earthwork)
Unit of Measure	m^3 [yd^3]
	D1050 Environmental Restoration/Replacement
Description	Environmental restoration/replacement is the activity of restoring or replacing elements of the environment disturbed by construction.
Includes	Restoration or replacement of wetlands
Excludes	
Unit of Measure	Hectare (Acre)
D SITEWORK	
D20 Approach Construction	
	D2010 Approach Slabs

TABLE 2 *Continued*

Description	An approach slab, supported by the bridge abutment on one side and a sleeper slab or soil on the other, provides a smooth transition between the roadway and the bridge, and spans any settlement gap between the abutment and the roadway.
Includes	Granular fill, drain tiles, concrete, reinforcing, and finishing
Excludes	Barrier and wing wall (see Barriers, Wing Walls)
Unit of Measure	m^2 [yd^2]
	D2020 Sleeper Slabs
Description	Sleeper slabs are rectangular concrete foundations that support approach slabs.
Includes	Excavation and backfill, concrete, reinforcing and finishing
Excludes	Approach slab (see Approach Slabs)
Unit of Measure	m^3 [yd^3]
	D2030 Earth Retention Systems
Description	Earth retention systems are designed to support embankments when the grades are not uniform.
Includes	Its foundation and wall
Excludes	Excavation and backfill (see Earthwork)
Unit of Measure	m^3 [yd^3] or m^2 [yd^2]

6.2 *Description*—The element descriptions help you understand the purpose and application of the element.

6.3 *Includes*—The purpose of the element inclusions is to list features that make up the element.

6.4 *Excludes*—The purpose of the element exclusions is to list features that are not included in the element, but which are included elsewhere in this classification.

NOTE 2—Because this classification refers solely to permanent physical parts of bridge constructions, references to construction enabling equipment (cranes, formwork, etc.), temporary construction (cofferdams, traffic detours, etc.), and risk mitigation (allowances and contingencies) cost figures are omitted from the element exclusions.

6.5 *Unit of Measure*—The purpose of the unit of measure is to provide a means for calculating the magnitude, or size, of each element in any transportation surface description; units of measure are important to all users of elemental classifications. Units of measure are of prime importance in the elemental cost management process. Both SI and inch-pound units are reported. SI units are reported first followed by inch-pound units within brackets. Table 2 uses the following unit of measure abbreviations: linear meters (m) and linear feet (ft); square meters (m^2) and square feet (ft^2); cubic meters (m^3) and cubic yards (yd^3); and kilograms (kg) and pounds (lb).

6.6 *Functions*—Appendix X3 lists functions of each element. Functions are listed as nonmandatory since they vary for bridges based on their intended usage.

7. Application

7.1 Appendix X2 uses a case study of the Gateway Arch Bridge construction project to demonstrate how to use the Classification E2103/E2103M and the example Sub-Classification provided in Appendix X1 to analyze and manage bridge design and construction costs. The Gateway Arch

Bridge was part of the reconstruction of Interstate 94 for the Super Bowl XL game held in 2006.[6]

8. Keywords

8.1 bridge assemblies; bridge cost estimation; bridge cost planning; bridge elemental format; bridge elements; bridge functional elements; bridge systems classification; construction; design economics; economic analysis; economic evaluation; elemental bridge classification; elemental/systems classification; life-cycle costing; master schedules; outline specifications; preliminary project description; risk analysis; sitework; standard classifications of bridge systems; UNIFORMAT II; value engineering

[6] For a comprehensive discussion of the uses of ASTM Building Economics Standards to design and construction applications in general and to the Gateway Arch Bridge in particular, see Kasi and Chapman, *Benefits of Using ASTM Building Economics Standards for the Design, Construction, and Operation of Constructed Facilities*, National Institute of Standards and Technology, Special Publication 1098, Gaithersburg, MD, 2012.

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE SUB-CLASSIFICATION OF BRIDGE ELEMENTS

X1.1 This appendix presents an example Sub-Classification of bridge elements. The Sub-Classification expands the Classification E2103/E2103M Level 3 Individual Elements into their constituent parts. These constituent parts include a Level 4 for all Individual Elements and, where necessary, a Level 5.

X1.2 The example Sub-Classification is presented in Table X1.1. Table X1.1 is laid out in a five-column format. The first column lists the Level 1 Major Group Elements. The second column lists the Level 2 Group Elements associated with each Level 1 Major Group Element. The third column lists the Level 3 Individual Elements associated with each Level 2 Group Element. The fourth column lists the Level 4 Sub-Elements associated with each Level 3 Individual Element. The fifth column lists any Level 5 Sub-Elements associated with a Level 4 Sub-Element. Where appropriate, the Level 5 Sub-Elements are listed in the normal chronological order of construction.

X1.3 Alphanumeric designators are included for all Level 1 Major Group Elements, Level 2 Group Elements, Level 3 Individual Elements, Level 4 Sub-Elements, and Level 5 Sub-Elements. It is anticipated that the alphanumeric designators will be useful in structuring cost manuals and in recording construction, operating, and maintenance costs in computer databases.

X1.4 Alphanumeric designators for the Classification E2103/E2103M presented in this appendix use a format similar to that employed in Classification E1557. Specifically, the format for the alphanumeric designators is as follows: Level 1, Major Group Elements, use a single capital letter; Level 2, Group Elements, use a two-digit number preceded by the Level 1 letter; and Level 3, Individual Elements, use a two-digit number preceded by the Level 2 character string.

X1.5 The alphanumeric designators for the example Sub-Classification uses the Level 3 Individual Element character string as their reference point. For example, the first Level 4 Sub-Element associated with the A1010 Foundations Level 3 Individual Element is A101010 Spread Footings. Additional Level 4 Sub-Elements associated with A1010 Foundations are: A101020 Piles and A101030 Drilled Shafts. For Level 5 Sub-Elements, the alphanumeric designator uses the Level 4 Sub-Element character string as their reference point. For example, the first Level 5 Sub-Element associated with the A101010 Spread Footings Level 4 Sub-Element is A10101010 Excavation. Additional Level 5 Sub-Elements associated with A101010 Spread Footings are: A10101020 Reinforcement; A10101030 Placement; and A10101040 Backfilling.

TABLE X1.1 Example Sub-Classification of Bridge Elements

Level 1 Major Group Elements	Level 2 Group Elements		Level 3 Individual Elements		Level 4 Sub-Elements		Level 5 Sub-Elements	
A Substructure	A10	Piers	A1010	Foundation	A101010	Spread Footings	A10101010	Excavation
							A10101020	Reinforcement
							A10101030	Placement
							A10101040	Backfilling
					A101020	Piles	A10102010	Test Piles
							A10102020	Piles
							A10102030	Pile Cap
					A101030	Drilled Shafts	A10103010	Permanent Casing
							A10103020	Rock Socket
							A10103030	Bell
							A10103040	Reinforcement
							A10103050	Placement
							A10103060	Cap
			A1020	Walls	A102010	Cast-in-Place Concrete	A10201010	Reinforcement
							A10201020	Placement
							A10201030	Finishing
							A10201040	Coating
					A102020	Precast Concrete	A10202010	Fabrication
							A10202020	Erection
			A1030	Columns	A103010	Cast-in-Place Concrete	A10301010	Reinforcement
							A10301020	Placement
							A10301030	Finishing
					A103020	Precast Concrete	A10302010	Fabrication
							A10302020	Erection
					A103030	Steel	A10303010	Fabrication
							A10303020	Erection
					A103040	Timber	A10304010	Fabrication
							A10304020	Erection
			A1040	Cap Beams	A104010	Cast-in-Place Concrete	A10401010	Reinforcement
							A10401020	Placement
							A10401030	Finishing
					A104020	Precast Concrete	A10402010	Fabrication
							A10402020	Erection
					A104030	Steel	A10403010	Fabrication
							A10403020	Erection
					A104040	Timber	A10404010	Fabrication
							A10404020	Erection
	A20	Towers	A2010	Foundations	A201010	Spread Footings	A20101010	Excavation
							A20101020	Reinforcement
							A20101030	Placement
							A20101040	Backfilling
					A201020	Pile Foundations	A20102010	Test Piles
							A20102020	Piles
							A20102030	Pile Cap
					A201030	Drilled Shafts	A20103010	Permanent Casing
							A20103020	Rock Socket
							A20103030	Bell
							A20103040	Reinforcement
							A20103050	Placement
							A20103060	Cap
			A2020	Walls	A202010	Cast-in-Place Concrete	A20201010	Reinforcement
							A20201020	Placement
							A20201030	Finishing
							A20201040	Coating
					A202020	Precast Concrete	A20202010	Fabrication
							A20202020	Erection
			A2030	Columns	A203010	Cast-in-Place Concrete	A20301010	Reinforcement
							A20301020	Placement
							A20301030	Finishing
					A203020	Precast Concrete	A20302010	Fabrication
							A20302020	Erection
					A203030	Steel	A20303010	Fabrication
							A20303020	Erection
					A203040	Timber	A20304010	Fabrication
							A20304020	Erection
			A2040	Cap Beams	A204010	Cast-in-Place Concrete	A20401010	Reinforcement
							A20401020	Placement
							A20401030	Finishing
					A204020	Precast Concrete	A20402010	Fabrication
							A20402020	Erection
					A204030	Steel	A20403010	Fabrication
							A20403020	Erection
					A204040	Timber	A20404010	Fabrication

TABLE X1.1 *Continued*

Level 1 Major Group Elements	Level 2 Group Elements		Level 3 Individual Elements		Level 4 Sub-Elements		Level 5 Sub-Elements	
							A20404020	Erection
	A30	Abutments	A3010	Foundations	A301010	Spread Footings	A30101010	Excavation
							A30101020	Reinforcement
							A30101030	Placement
							A30101040	Backfilling
					A301020	Piles	A30102010	Test Piles
							A30102020	Piles
							A30102030	Pile Cap
					A301030	Drilled Shafts	A30103010	Permanent Casing
							A30103020	Rock Socket
							A30103030	Bell
							A30103040	Reinforcement
							A30103050	Placement
							A30103060	Cap
			A3020	Stems	A302010	Cast-in-Place Concrete	A30201010	Reinforcement
							A30201020	Placement
							A30201030	Finishing
					A302020	Precast Concrete	A30202010	Fabrication
							A30202020	Erection
			A3030	Wing Walls	A303010	Cast-in-Place Concrete	A30301010	Reinforcement
							A30301020	Placement
							A30301030	Finishing
					A303020	Precast Concrete	A30302010	Fabrication
							A30302020	Erection
	A40	Other Supports	A4010	Thrust Blocks	A401010	Cap	A40101010	Reinforcement
							A40101020	Placement
							A40101030	Finishing
					A401020	Foundation	A40102010	Spread Footings
							A40102020	Piles
							A40102030	Drilled Shafts
			A4020	Anchorages	A402010	Prestressed	A40201010	Spray Saddle
							A40201020	Anchor
					A402020	Cast-in-Place Concrete	A40202010	Reinforcement
							A40202020	Placement
					A402030	Foundations	A40203010	Spread Footings
							A40203020	Piles
							A40203030	Drilled Shafts
B Superstructure	B10	Short Span Assemblies	B1010	Flexural Members	B101010	Cast-in-Place Concrete	B10101010	Reinforcement
							B10101020	Placement
							B10101030	Finishing
					B101020	Precast Concrete	B10102010	Fabrication
							B10102020	Erection
					B101030	Steel	B10103010	Fabrication
							B10103020	Erection
					B101040	Timber	B10104010	Fabrication
							B10104020	Erection
			B1020	Diaphragms	B102010	Cast-in-Place Concrete	B10201010	Reinforcement
							B10201020	Placement
					B102020	Precast Concrete	B10202010	Fabrication
							B10202020	Erection
					B102030	Steel	B10203010	Fabrication
							B10203020	Erection
					B102040	Timber		
			B1030	Bracings	B103010	Steel	B10301010	Fabrication
							B10301020	Erection
					B103020	Timber		
			B1040	Bearings	B104010	Elastomeric		
					B104020	Sliding		
					B104030	Roller		
	B20	Long Span Assemblies	B2010	Ribs	B201010	Cast-in-Place Concrete	B20101010	Reinforcement
							B20101020	Placement
					B201020	Precast Concrete	B20102010	Fabrication
							B20102020	Erection
					B201030	Steel	B20103010	Fabrication
							B20103020	Erection
			B2020	Cables	B202010	Wires		
					B202020	Sockets		
					B202030	Saddles		
					B202040	Housings		
					B202050	Strands		
					B202060	Anchor Sockets		
			B2030	Hangers	B203010	Top Anchor Socket		