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Chapter 1 : Superstructure - Wikipedia

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Other types are listed in the Bridge Terminology page. The drawings are not to scale. Additional related info is found on the other Terminology pages which are linked to the left. The four main factors are used in describing a bridge. By combining these terms one may give a general description of most bridge types. The three basic types of spans are shown below. Any of these spans may be constructed using beams, girders or trusses. Arch bridges are either simple or continuous hinged. A cantilever bridge may also include a suspended span. Examples of the three common travel surface configurations are shown in the Truss type drawings below. In a Deck configuration, traffic travels on top of the main structure; in a Pony configuration, traffic travels between parallel superstructures which are not cross-braced at the top; in a Through configuration, traffic travels through the superstructure usually a truss which is cross-braced above and below the traffic. Beam and Girder types Simple deck beam bridges are usually metal or reinforced concrete. Other beam and girder types are constructed of metal. The end section of the two deck configuration shows the cross-bracing commonly used between beams. The pony end section shows knee braces which prevent deflection where the girders and deck meet. Usually the center section is a standard shape with parallel flanges; curved or angled flanged ends are riveted or bolted using splice plates. Because of the restrictions incurred in transporting large beams to the construction site, shorter, more manageable lengths are often joined on-site using splice plates. Many modern bridges use new designs developed using computer stress analysis. The rigid frame type has superstructure and substructure which are integrated. Commonly, the legs or the intersection of the leg and deck are a single piece which is riveted to other sections. Orthotropic beams are modular shapes which resist stress in multiple directions at once. They vary in cross-section and may be open or closed shapes. Arch types There are several ways to classify arch bridges. The placement of the deck in relation to the superstructure provides the descriptive terms used in all bridges: Also the type of connections used at the supports and the midpoint of the arch may be used - - counting the number of hinges which allow the structure to respond to varying stresses and loads. A through arch is shown, but this applies to all type of arch bridges. Another method of classification is found in the configuration of the arch. Examples of solid-ribbed, brace-ribbed trussed arch and spandrel-braced arches are shown. A solid-ribbed arch is commonly constructed using curved girder sections. A brace-ribbed arch has a curved through truss rising above the deck. A spandrel-braced arch or open spandrel deck arch carries the deck on top of the arch. Some metal bridges which appear to be open spandrel deck arch are, in fact, cantilever; these rely on diagonal bracing. A true arch bridge relies on vertical members to transmit the load which is carried by the arch. The tied arch bowstring type is commonly used for suspension bridges; the arch may be trussed or solid. The trusses which comprise the arch will vary in configuration, but commonly use Pratt or Warren webbing. While a typical arch bridge passes its load to bearings at its abutment; a tied arch resists spreading drift at its bearings by using the deck as a tie piece. Masonry bridges, constructed in stone and concrete, may have open or closed spandrels A closed spandrel is usually filled with rubble and faced with dressed stone or concrete. Occasionally, reinforced concrete is used in building pony arch types. Truss - simple types A truss is a structure made of many smaller parts. Once constructed of wooden timbers, and later including iron tension members, most truss bridges are built of metal. Types of truss bridges are also identified by the terms deck, pony and through which describe the placement of the travel surface in relation to the superstructure see drawings above. The king post truss is the simplest type; the queen post truss adds a horizontal top chord to achieve a longer span, but the center panel tends to be less rigid due to its lack of diagonal bracing. Covered bridge types truss Covered bridges are typically wooden truss structures. The enclosing roof protected the timbers from weathering and extended the life of the bridge. One of the more common methods used for achieving longer spans was the multiple kingpost truss. A simple, wooden, kingpost truss forms the center and panels are added symmetrically. With the use of iron in bridge construction, the Howe truss - - in its simplest form - - appears to be a type of multiple kingpost truss. Long was one of the U. Army Topographical Engineers sent to explore and map the United States as it expanded westward. While working for the Baltimore and Ohio Railroad, he developed the X truss in with further improvements patented in and The wooden truss was also known as the Long truss and he is cited as the first American to use mathematical calculations in truss design. By adding a arch segments to a multiple kingpost truss, the Burr arch truss was able to attain longer spans. His truss design, patented in , is not a true arch as it relies on the interaction of the arch segments with the truss members to carry the load. There were many of this type in the Pittsburgh area and they continue to be one of the most common type of covered bridges. Many later covered bridge truss types used an added arch based on the success of the Burr truss. The Town lattice truss was patented in by Ithiel Town. The lattice is constructed of planks rather than the heavy timbers required in kingpost and queenpost designs. It was easy to construct, if tedious. Town licensed his design at one dollar per foot - - or two dollars per foot for those found not under license. Wayne railroad bridge over the Allegheny River was an unusual instance of a Town lattice constructed in iron. Herman Haupt designed and patented his truss configuration in He was in engineering management for several railroads including the Pennsylvania Railroad and drafted as superintendent of military railroads for the Union Army during the Civil War. The Haupt truss concentrates much of its compressive forces through the end panels and onto the abutments. Other bridge designers were busy in the Midwest. An OhioDOT web page cites examples of designs used for some covered bridges in that state. Smith of Tipp City, OH, received patents in and for his designs. Three variations of the Smith truss are still standing in Ohio covered bridges. Partridge received a patent for his truss design which is appears to be a modification of the Smith truss. The Childs truss was used exclusively by Ohio bridge builder Everett Sherman after Truss - Pratt variations The Pratt truss is a very common type, but has many variations. Originally designed by Thomas and Caleb Pratt in , the Pratt truss successfully made the transition from wood designs to metal. The basic identifying features are the diagonal web members which form a V-shape. The center section commonly has crossing diagonal members. Additional counter braces may be used and can make identification more difficult, however the Pratt and its variations are the most common type of all trusses. Parker modified the Pratt truss to create a "camelback" truss having a top chord which does not stay parallel with the bottom chord. This creates a lighter structure without losing strength; there is less dead load at the ends and more strength concentrated in the center. It is somewhat more complicated to build since the web members vary in length from one panel to the next. When additional smaller members are added to a Pratt truss, the various subdivided types have been given names from the railroad companies which most commonly used each type, although both were developed by engineers of the Pennsylvania Railroad in the s. The Whipple truss was developed by Squire Whipple as stronger version of the Pratt truss. Patented in , it was also known as the "Double-intersection Pratt" because the diagonal tension members cross two panels, while those on the Pratt cross one. The Indiana Historical Bureau notes one bridge as being a "Triple Whipple" -- possibly the only one -- built with the thought that if two are better than one, three must be stronger yet. The Whipple truss was most commonly used in the trapezoidal form -- straight top and bottom chords -- although bowstring Whipple trusses were also built. The Whipple truss gained immediate popularity with the railroads as it was stronger and more rigid than the Pratt. It was less common for highway use, but a few wrought iron examples survive. They were usually built where the span required was longer than was practical with a Pratt truss. Further developments of the subdivided variations of the Pratt, including the Pennsylvania and Baltimore trusses, led to the decline of the Whipple truss. Truss - Warren variations A Warren truss, patented by James Warren and Willoughby Monzoni of Great Britain in , can be identified by the presence of many equilateral or isoceles triangles formed by the web members which connect the top and bottom chords. These triangles may also be further subdivided. Warren truss may also be found in covered bridge designs. Truss - other types The other truss types shown are less common on modern bridges. A Howe truss at first appears similar to a Pratt truss, but the Howe diagonal web members are inclined toward the center of the span to form A-shapes. The vertical members are in tension while the diagonal members are in compression, exactly opposite the structure of a Pratt truss. Patented in by William Howe, this design was common on early railroads. The three drawings show various levels of detail. The thicker lines represent wood braces; the thinner lines are iron tension rods. The Howe truss was patented as an improvement to the Long truss which is discussed with covered bridge types. Friedrich August von Pauli published details of his truss design in Its opposing arches combine the benefits of a suspension bridge with those of an arch bridge. But like the willow tree, some of its strength is expressed in its flexibility which is often noticeable to bridge traffic.

Chapter 2 : modern prestressed concrete highway bridge calendrierdelascience.com - PDF Free Download

Superstructures is a structural engineering consulting firm based in Pretoria, South Africa. The firm is branched into a bridge specialist department and a commercial and industrial buildings department.

This book has been written with the principal purpose of describing the design methods that are applicable to the various major types of sed concrete highway bridge superstructures currently in use in the United States. Secondary purposes have been to describe the advantages and disadvantages of the various bridge types and to briefly discuss the construction methods used with the different types. Reinforced concrete bridge superstructures are not considered. The fundamental principles of reinforced concrete and prestressed concrete structural design are not presented in this book. It is presumed the reader is competent in the design of these forms of concrete construction Ref. Finally, it is presumed the reader is familiar with the fundamental principles of structural analysis. Bridges which employ -precast members used primarily in building construction, such as double-tee beams, single-tee beams, hollow-core slabs and solid precast slabs, are discussed briefly, but are not treated in detail. No attempt has been made to include a discussion discussion of unique bridges utilizing specially fabricated precast sections peculiar to the specific bridge even though the bridge might be considered to be a major structrue. Specific cost data have not been included in the discussions of the various types of bridges. Construction costs vary with the constantly changi changing ng econom economy y of the natio nation. The result result is that that specifi specificc cost data are are normally only accurate for a short period of time. Relative construction costs vary throughout the country and hence escape anything but vague generalizations. These publications are highly recommended to all who are interested in the design of concrete bridges. Like other structures, bridges must be designed for the dead and live loads to which they are subjected. The dead loads consist of the self-weight of the basic structural section itself as well as superimposed dead loads such as bridge railings, sidewalks, non-structural wearing surfaces, and utilities which the structure must support. Live loads are those due to the effect of external causes and are generally transient in nature. Other live loads are secondary in nature and result from impact forces. Vertical impact forces are created by the vehicles using the structure. Horizonal impact forces result from braking and turning of these vehicles. The minimum live loads for which bridge structures must be designed are generally specified by design criteria such as the AASHTO Specification. Considerable differences exist in the live load design criteria used throughout the world. Much has been written on this as well as on the fact that the criteria used in the United States may be unrealistically low and may not be representative of the actual loads to which our bridges are exposed Ref. It may very well be that other requirements of the AASHTO Specifications compensate to some degree for the relatively light design live loads specified therein. The design loads that must be considered in the design of reinforced concrete and prestressed concrete are identical except for those caused by volume changes. This is due to the fact that non-prestressed reinforcing steel tends to resist concrete shrinkage strains and, in reinforced concrete members, promotes the formation of fine cracks. The fine cracks relieve the shrinkage stresses in the concrete as well as the need for the member to shorten. The important effect of concrete creep on reinforced concrete members is the dependent effect on deflection. In prestressed concrete the cracking mechanism related to shrinkage does not take place and provision must be made for the total shrinkage strain which may occur and cause undesirable effects. In prestressed concrete creep and shrinkage both affect deflection. This must be considered in the design. Shortening due to creep and shrinkage can be significant in prestressed concrete structures and must be taken into account if good results are to be obtained. Although there are considerable data in the literature relative to creep and shrinkage of concrete, there is no accepted U. Methods have been proposed in the literature Ref. For the benefit of the reader, the methods used for predicting concrete shrinkage and creep in the French Code Ref. The smaller live loads were originally intended for use on secondary roads but not on primary highways. Each IO-foot wide truck or lane l ane It load is to be positioned in a design traffic lane which is twelve feet wide. For bridges which are designed for three or more design traffic lanes, Section 1. The live load distribution factors which are contained in Section 1. The approximate methods are applicable to most conditions encountered in practice.

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Sophisticated methods of analyzing bridge structures including the 14 I.

Chapter 3 : Bridge Design Manual - LRFD: Lateral Restraint of Bridge Superstructures on Substructure

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References Superstructures The superstructure of a bridge is made up of the portion of the bridge built on top of the substructure and supports the bridge deck. Several materials and structural configurations can be used to make up the superstructure of a bridge, but this report will focus more on short span steel bridges. A publication from the Short Span Steel Bridge Alliance provides different short span bridge superstructures using different steel configurations depending on spans that the bridge must support. This section will describe several different steel superstructures, illustrate the different structure types and evaluate the different systems for short span modular steel bridges. Corrugated Steel Pipe Description Corrugated steel piping is a form of prefabricated steel superstructure that can be installed rapidly. Due to newly developed steel grades with many beneficial properties, a steel superstructure like this can be lightweight, strong and cost efficient. The Short Span Steel Bridge Alliance brochure recommends this type of superstructure for spans under approximately 15 feet. An example of Corrugated Steel Pipe can be seen in Figure The sections that make up the pipe are also bolted together. Couplings are used to prohibit soil and water from getting through the sides of the corrugated steel pipe. Reinforcement may be applied to the pipe to provided extra strength. Backfill and an earth retention system is used to make up the rest of the structure that supports the roadway. These pipes also come in a variety of sizes providing a variety of lower-end spans to which they can be applied. Research Needed Corrugated Structural Plates Description Corrugated structural plates are another prefabricated steel option for a superstructure. These structural plates are formed in such a way to support the rest of the bridge structure and still allow for the traversed travel way to be usable. The Short Span Steel Bridge Alliance brochure recommends this form of steel superstructure for spans between approximately 5 and 60 feet. An example of a bridge using this type of steel superstructure can be seen in Figure Bolts are also used to connect the sections of the corrugated steel plate and connect the section to the end treatments. Reinforcement is generally added to the plates in order to provide extra strength to the structure. Earth retaining structures and backfill make up the rest of the structure to support the roadway. There are a wide range of designs that allow for these to be used on a variety of spans. Research Needed Of the several different reinforcing ribs being used to stiffen structural plate culverts, only a select few have published composite properties. There is a need for research in the area of the degree of composite action of ribs with structural plate culverts. This research can lead to a more efficient use of the combined strength of the materials and aid in developing more cost efficient designs. These lightweight panels provide more stiffness than a conventional structural plate bridge. The panels are easy to transport and required significantly less bolts than the conventional steel plate. The panels are light enough that they can be assembled next to job-site and then moved into place by relatively light equipment. This system also has the advantage of being adaptable; it can be widened easily by adding more panels and adapting the rest of the structure. The superstructure supports the deck and applied live loads while allowing for traversing traffic underneath the bridge. Earth retaining structures and backfill make up the rest of the bridge structure that supports the roadway. This system has the added benefit of being easily widened by adding more of the angular plates used to make the initial structure. Also, with the light weight, being able to construct the clearing and then move it to the required location can be beneficial in lessening the time for traffic impact. Research Needed Wide Flange Shapes Description Wide flange shapes are used as a common superstructure element for bridges between approximately 20 and 90 feet. These elements are aligned parallel to traffic flow under the bridge deck to support the loads of the bridge. Generally the deck is attached to the girders in such a way to make the deck and girders behave cooperatively as composite members. While in longer spans the unit weight of steel used for the bridge can be higher than that of steel plate girders, the unit cost of steel is much lower for rolled members. Transverse stiffeners are not normally required for rolled sections and simple diaphragm details aid in making rolled sections an affordable superstructure. An example of a wide flange rolled steel bridge is provided in Figure Bridge Tour Application The Short Span Steel

Bridge Alliance brochure implies that this alternative can be applied to spans between approximately 20 and 90 feet. The superstructure supports the deck and applied live loads and provides clearance for traverse beneath the bridge. During erection, pier brackets are often used to provide stability to negative moment sections of the bridge until the positive moment sections are erected. The unit weight of steel for the bridge is higher than that of plate girder bridges, though. Research Needed Plate Girders Description Steel plate girders are one of the most common steel superstructure elements. When used in a bridge structure, the plate girders are installed parallel with the direction of traffic. Floorbeams are placed transversely under the deck to distribute the bridge loads. Similar to rolled steel wide flange members, the deck is placed causing the deck and girders to act as composite members. The shape of steel plate girders differ from rolled sections in that rolled sections are doubly-symmetric "I-shaped" sections and steel plate girders can be detailed to be more efficient and are generally only singularly-symetric. These customizing options cause steel plate girders to have a lighter unit weight. The more difficult diaphragm details and the need for transverse stiffeners lead to this choice not always being as cost-efficient as rolled sections for a wide range of short span situations. An example of a bridge using steel plate girders is provided in Figure Similar to rolled steel sections, this system acts as a composite section with the deck. Despite the trusses being composed of discrete members arranged to form triangles that are subjected primarily to axial loads, the two trusses generally react like two large support beams. Floorbeams are attached to the truss and run perpendicular to the flow of traffic to support the bridge loads that are distributed by stringers that run parallel with the flow of traffic. The top and bottom members of the truss system, chords, are often attached laterally to provide stiffness and resistance to wind loads. For the Cambridge Steel Truss Bridge, the top chords are generally arched. This type of superstructure can support bridges of varying spans. There are of course several more members to be assembled in a truss system than in other superstructure methods. Because of the lighter member size, smaller cranes can be used in the construction process. The elements are connected to one another using bolted connections. For simple span trusses, falsework towers are usually required to facilitate erection. For continuous trusses, a cantilever erection can be used using falsework towers near the interior piers. The erection process can be much more complicated than that of steel plate girder bridges. Some companies are transporting the trusses as prefabricated elements to the bridge site, quickening the bridge construction process. Research Needed Warren Steel Truss Bridge Description This superstructure system is similar to the Cambridge Steel Truss Bridge system in that it consists of two trusses acting continuously between the abutments of the bridge. Again, the trusses are made up of top and bottom chords with axially loaded discrete members between them. This truss system differs from the Cambridge system in that the top and bottom chords are parallel and all of the discrete sections are arranged in a way to create inverted alternating equilateral triangles. The diagonals are welded to the top and bottom chords. The truss sections are delivered to the job-site by truck to be assembled. During erection the sections are supported by permanent pier or temporary support. The trusses will be used to support the falsework to be used for the deck placement. Also these bridges can be more complex to construct unless set as a modular system. Research Needed Steel Space Truss Bridge Description Where the last two truss systems involved planar trusses, steel space trusses are constructed to be three-dimensional. For this truss scenario, the truss is composed of one chords connected in three planes by the axial members to form a triangular shape. These superstructure elements can be difficult to use for bridge construction unless they are installed as modular sections. An example of a steel space truss bridge is provided in Figure 27 and a view of a typical section of a steel space truss bridge is provided in Figure These sections are transported to the bridge site by truck. The modulated units are installed using erection beams or temporary falsework. Erection beams would be installed between abutments and piers to support the modular sections and lessening traffic disruption. The deck can then be installed atop the superstructure. Due to the three-dimensional truss system, these can be difficult to construct on site unless the elements are installed as modular sections.

Chapter 4 : Superstructures

the design and analysis of both steel and concrete highway bridge superstructures. The design examples, as well as the *training course, are based on the.*

Chapter 5 : Bridge Basics - A Spotter's Guide to Bridge Design

Anchor: #i Section 9: Lateral Restraint of Bridge Superstructures on Substructure Anchor: #i General. Lateral movement of superstructures can occur on water crossings due to flooding events and on grade separations due to cross slope with certain beam types.

Chapter 6 : Bridge Design Manual - LRFD: Superstructure Design

Bridge Superstructure Design, and Section 6, Bridge Substructure Design. In the past the office followed AASHTO Standard Specifications but now has transitioned to AASHTO LRFD Specifications for superstructure design.

Chapter 7 : Bridges - Design

LRFD for Highway Bridge Superstructures (2-day Concrete ILT) This updated course describes Load and Resistance Factor Design (LRFD) for concrete highway bridge superstructures. It provides a combination of instructor-led discussions and workshop exercises.