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BRIDGE COMPONENTS AND ELEMENTS

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ABSTRACT

The bridge inspector should be familiar with the terminology and elementary theory of bridge mechanics and materials. This topic presents the terminology needed by inspectors to properly identify and describe the individual elements that comprise a bridge**.**

Keywords: Bridge Components and Elements, Graphics, Building, Architect, Engineer, Project, Computer.

INTRODUCTION

First the major components of a bridge are introduced. Thenthe basic member shapes and connections of the bridge are presented. Finally, the purpose and function of the major bridge components are described in detail.According to the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* the minimum length for a structure carrying traffic loads is 6.1meters (20 feet). The structure length is measured as shown on Figure P.1.1

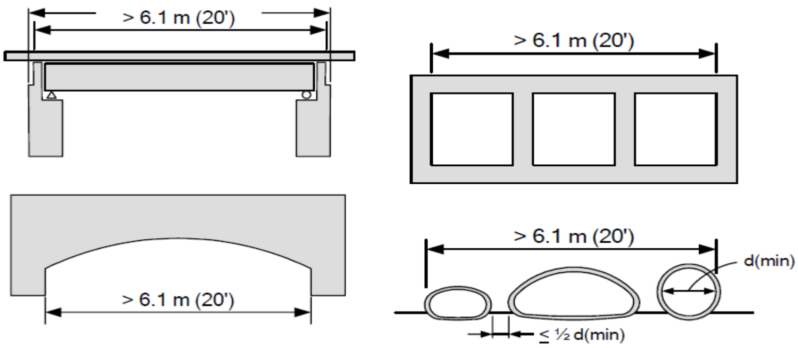

Figure P.1.1 NBIS Structure Length

23 CFR Part 650.305 Definitions gives the definition of a bridge as it applies to the NBIS regulations. From the NBIS regulations, a bridge is defined as follows: a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway

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of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening. A thorough and complete bridge inspection is dependent upon the bridge inspector's ability to identify and understand the function of the major bridge components and their elements. Most bridges can be divided into three basic parts or components (see Figure P.1.1A):

1.Deck
2.Superstructure
3.Substructure

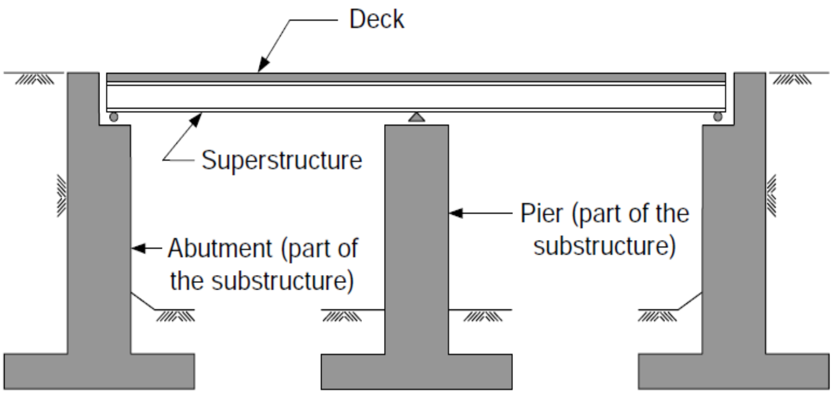

Figure P.1.1A Major Bridge Components

METHODOLOGY

The ability to recognize and identify basic member shapes requires an understanding of the timber, concrete, and steel shapes used in the construction of bridges. Every bridge member is designed to carry a unique combination of tension, compression, and shear. These are considered the three basic kinds of member stresses. Bending loads cause a combination of tension and compression in a member. Shear stresses are caused by transverse forces exerted on a member. As such, certain shapes and materials have distinct characteristics in resisting the applied loads. For a review of bridge loadings and member responses, see Topic P.2.

Basic shapes, properties, gradings, deteriorations, protective systems, and examination of timber are covered in detail in Topic 2.1. Timber members are found in a variety of shapes (see Figure P.1.2). The sizes of timber members are generally given in nominal dimensions (such as in Figures P.1.2 and P.1.3). However, timber members are generally seasoned and surfaced from the rough sawn condition, making

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the actual dimension about 13 to 20 mm (1/2 to 3/4 inches) less than the nominal dimension.

RESULTS AND DISCUSSION

The physical properties of timber enable it to resist both tensile and compressive stresses. Therefore, it can function as an axially-loaded or bending member. Timber bridge members are made into three basic shapes:

-Planks
-Beams
-Piles

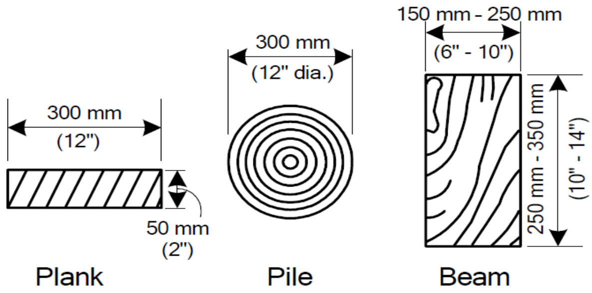

Figure P.1.2 Timber Shapes

Planks

Planks are characterized by elongated, rectangular dimensions determined by the intended bridge use. Plank thickness is dependent upon the distance between the supporting points and the magnitude of the vehicle load. A common dimension for timber planks is a 50 mm x 300 mm (2" x 12"), nominal or rough sawn. Dressed lumber dimensions would be 38 mm x 285 mm (1 ½" x 11 ¼") (see Figure P.1.2).

Planks are most often used for bridge decks on bridges carrying light or infrequent truck traffic. While some shapes and materials are relatively new, the use of timber plank decks has existed for centuries. Timber planks are advantageous in that they are economical, lightweight, readily available, and easy to erect.

Beams

Timber beams have more equal rectangular dimensions than do planks, and they are sometimes square. Common dimensions include 250 mm by 250 mm (10 inches by 10 inches) square timbers, and 150 mm by 350 mm (6 inches by 14 inches) rectangular timbers. As the differences in the common dimensions of planks and timber beams indicate, beams are larger and heavier than planks and can support heavier loads, as well as span greater distances. As such, timber beams are used in bridge superstructures and substructures to carry bending and axial loads. Timbers can either be solid sawn or glued-laminated (see Figure P.1.3).

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Gluedlaminatedtimbers are advantageous in that they can be fabricated from smaller, more readily available pieces. Glued lamination also allows larger rectangular members to be formed without the presence of natural defects such as knots. Glued-laminated timbers are normally manufactured from well-seasoned laminations and display very little shrinkage after they are fabricated.

SECTION P: Basics Concepts Primer

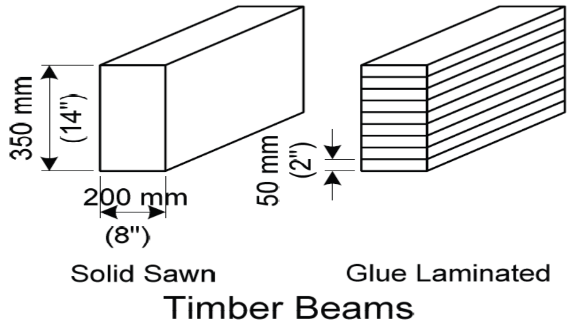

Figure P.1.3 Timber Beams

Piles

Timber can also be used for piles. Piles are normally round, slender columns that support the substructure footing or partially form the substructure. Piles may be partially above ground or completely buried. Basic ingredients, properties, reinforcement, deterioration, protective systems, and examination of concrete are covered in detail in Topic 2.2.

Figure P.1.4 Unusual Concrete Shapes

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Concrete is a unique material for bridge members because it can be formed into an infinite variety of shapes (see Figure P.1.4). Concrete members are used to carry axial and bending loads. Since bending results in a combination of compressive and tensile stresses, concrete bending members are typically reinforced with either reinforcing steel (producing reinforced concrete) or with prestressing steel (producing prestressed concrete) in order to carry the tensile stresses in the member.

Cast-in-Place Flexural Shapes

The most common shapes of reinforced concrete members are (see Figure P.1.5):
1. Slabs/Decks
2. Rectangular beams
3.Tee beams
4. Channel beams

Bridges utilizing these shapes and mild steel reinforcement have been constructed and were typically cast-in-place (CIP). Many of the designs are obsolete, but the structures remain in service. Concrete members of this type are used for short and medium span bridges.

Axially-Loaded Compression Members

Concrete axially-loaded compression members are used in bridges in the form of:
1. Columns
2. Arches
3. Piles

Because these members also carry varying bending forces, they contain steel reinforcement.

Columns are straight members which can carry axial load, horizontal load, and bending and are used as substructure elements. Columns are commonly square, rectangular, or round.

An arch can be thought of as a curved column and is commonly used as a superstructure element. Concrete superstructure arches are generally square or rectangular in cross section.

Piles are slender columns that support the substructure footing or partially form the substructure. Piles may be partially above ground but are usually completely buried (see Figure P.1.8).

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Figure P.1.8 Concrete Pile Bent

CONCLUSION

Thus, Iron was used predominately as a bridge material between 1850 and 1900. Stronger and more fire resistant than wood, iron was widely used to carry the expanding railroad system during this period. There are two types of iron members: cast iron and wrought iron. Cast iron is formed by casting, whereas wrought iron is formed by forging or rolling the iron into the desired form.

Figure 1.9 Cable-Supported Bridges

Cast Iron

Historically, cast iron preceded wrought iron as a bridge material. The method of casting molten iron to form a desired shape was more direct than that of wrought iron. Casting allowed iron to be formed into almost any shape. However, because of

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cast iron's brittleness and low tensile strength, bridge members of cast iron were best used to carry axial compression loads. Therefore, cast iron members were usually cylindrical or box-shaped to efficiently resist axial loads.

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