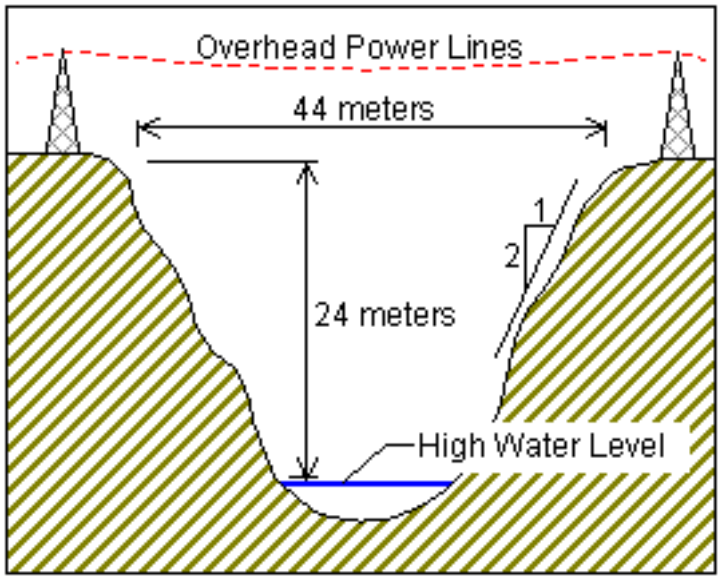
Design Specifications

All of the specifications listed below are built into the **West Point Bridge Designer 2014**. If you follow the design process , **WPBD** will ensure that you satisfy the specifications. They are listed here only so that you can better understand the sorts of requirements and constraints that engineers must consider when they design real bridges.

1. **The Problem**

   Your are a civil engineer working for the state department of transportation. You have been assigned responsibility for the design of a truss bridge to carry a two-lane highway across the river valley shown below.



2. **Design Objective**

   Satisfy all of the specifications listed below, while keeping the total cost of the project as low as possible.

3. **Bridge Configuration**

   a. The bridge may cross the valley at any elevation from the high water level to 24 meters above the high water level.

   b. If the elevation of the bridge deck is below 24 meters, excavation of the river banks will be required to achieve the correct highway elevation. (The amount of excavation required at each deck elevation is determined automatically by the **West Point Bridge Designer 2014**.)

   c. To provide clearance for overhead power lines (shown above), the highest point on the bridge may not exceed an elevation 32.5

meters above the high water level (8.5 meters above the top of the river banks).

d. The bridge substructure may consist of either standard abutments (simple supports) or arch abutments (arch supports). If necessary, the bridge may also use one intermediate pier, located near the center of the valley. If necessary, the bridge may also use cable anchorages, located 8 meters behind one or both abutments.

e. Each main truss can have no more than 100 joints and no more than 200 members.

f. The bridge will have a flat, reinforced concrete deck. Two types of concrete are available:

   1. Medium-strength concrete requires a deck thickness of 23 centimeters (0.23 meter).
   2. High-strength concrete requires a deck thickness of 15 centimeters (0.15 meter).

g. In either case, the deck will be supported by transverse floor beams spaced at 4 meter intervals. (See Component Parts of a Truss Bridge for more information about these terms.) To accommodate these floor beams, your structural model must have a row of joints spaced 4 meters apart at the level of the deck. These joints are created automatically when you begin a new design.

h. The bridge deck will be 10 meters wide, such that it can accommodate two lanes of traffic.

4. **Member Properties**

a. Materials. Each member of the truss will be made of either carbon steel, high-strength low-alloy steel, or quenched and tempered steel.

b. Cross-Sections. The members of the truss can be either solid bars or hollow tubes. Both types of cross-sections are square.

c. Member Size. Both cross-sections are available in a variety of standard sizes.

5. **Loads**

The bridge must be capable of safely carrying the following loads:

a. Weight of the reinforced concrete deck.

b. Weight of a 5-cm thick asphalt wearing surface, which might be applied at some time in the future.

c. Weight of the steel floor beams and supplemental bracing members (assumed to be 12.0 kN applied at each deck-level joint).

d. Weight of the main trusses.

e. Either of two possible truck loadings:

1. Weight of one standard H25 truck loading per lane, including appropriate allowance for the dynamic effects of the moving load. (Since the bridge carries two lanes of traffic, each main truss must safely carry one H25 vehicle, placed anywhere along the length of the deck.)

2. Weight of a single 480 kN Permit Loading, including appropriate allowance for the dynamic effects of the moving load. (Since the Permit Loading is assumed to be centered laterally, each main truss must safely carry one-half of the total vehicle weight, placed anywhere along the length of the deck.)

6. **Structural Safety**

The bridge will comply with the structural safety provisions of the 1994 LRFD AASHTO Bridge Design Specification (Load and Resistance Factor Design), to include:

a. Material densities

b. Load combinations

c. Tensile strength of members

d. Compressive strength of members

7. **Cost**

The cost of the design will be calculated using the following cost factors:

a. Material Cost:

Carbon steel bars - $4.50 per kilogram

Carbon steel tubes - $6.30 per kilogram

High-strength steel bars - $5.00 per kilogram

High-strength steel tubes - $7.00 per kilogram

Quenched and tempered steel bars - $5.55 per kilogram

Quenched and tempered steel tubes - $7.75 per kilogram

b. Connection Cost: $500.00 per joint

c. Product Cost: $1000.00 per product

d. Site Cost:

Reinforced concrete deck (medium strength) - $5,150 per 4-meter panel

Reinforced concrete deck (high strength) - $5,300 per 4-meter panel

Excavation - $1.00 per cubic meter (See the Site Design Wizard for excavation volume)

Supports (abutments and pier) - Cost varies (See the Site Design Wizard for specific values)

Cable Anchorages - $6,000 per anchorage

Notes and Tips

The West Point Bridge Designer 2014 ensures that your design satisfies all of the design specifications listed above. The Drawing Board is automatically set up so that your bridge has the correct span length, height, and supports. WPBD automatically calculates the loads and the resulting member forces. When you run the load test, it performs the AASHTO structural safety checks and, if any of the members in your structural model are not strong enough, it tells you which ones need it be strengthened. It also calculates the cost of your design automatically.

The AASHTO safety standards have been simplified considerably in the West Point Bridge Designer 2014. That's one important reason why the software is **for educational use only**. For more information, see What is Not Realistic about WPBD.