Superstructure Guidelines

The following are additional guidelines on using the following types of superstructure.

Pre-stressed Concrete Beams

To check beam size use the beam size chart. The chart was created using LRFD methodology. Beam spacing is ideally 8' to 10' for economy.

Seven I-beam sections are available for use in Minnesota. These sections range in depth from 27 inches to 81 inches. Identical top flange dimensions and identical bottom flange dimensions are used for each section. All should have 6-inch thick webs. The only variation is the web height.

Set the minimum deck overhang beyond the edge of the fascia beam flange at 6 inches.

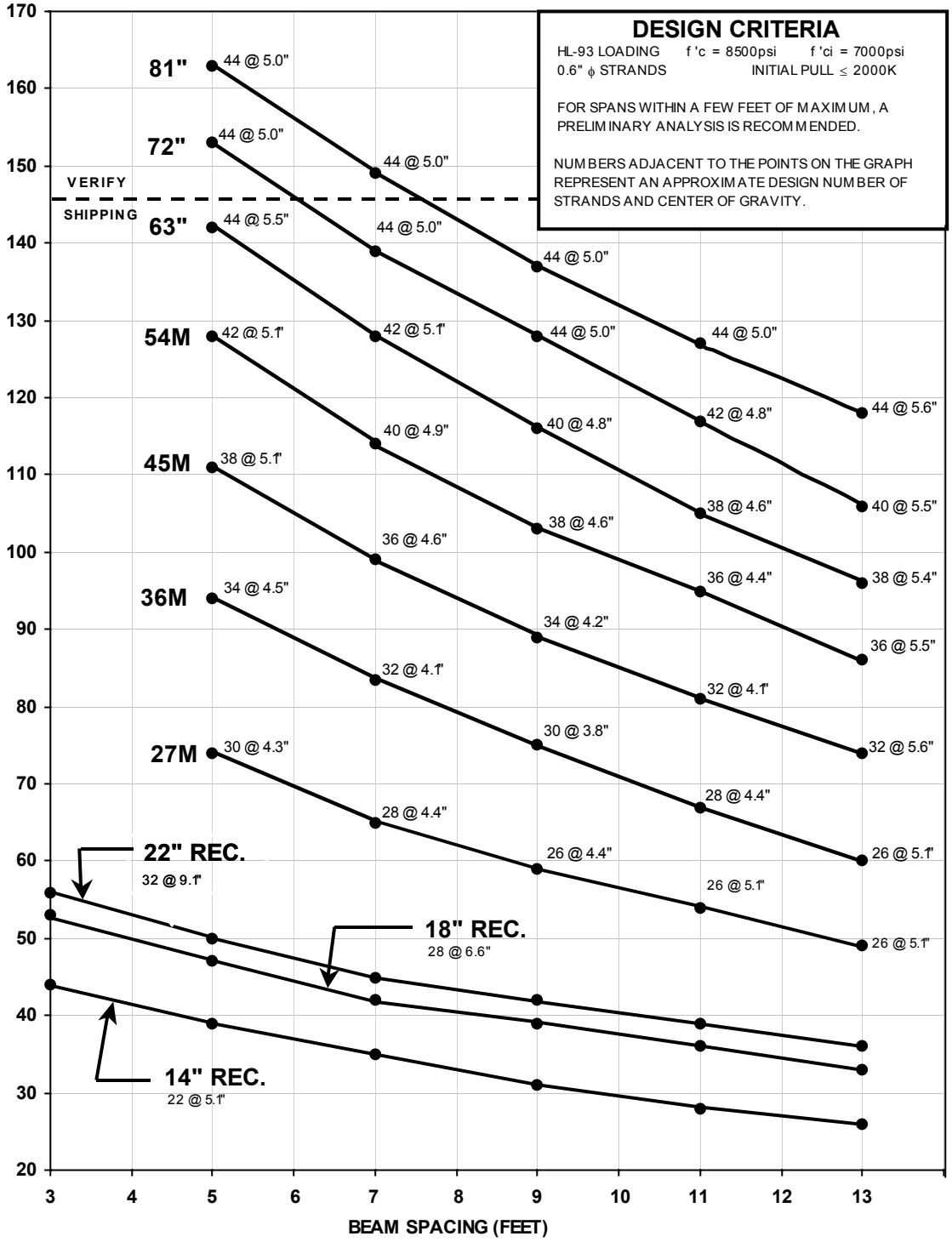
The maximum overhang (measured from centerline of fascia beam) should not exceed the smallest of the following three values:

- Depth of beam
- 40% of lateral beam spacing
- 32 inches plus 1/2 of the top flange width

The low member elevation should be set at:

Overtopping <100yr w/ no debris problem or velocity <5fps	Overtopping TW
Overtopping <100yr w/ debris problem and velocity ≥5fps	Overtopping TW + 1'
Overtopping ≥100yr w/ no debris problem or velocity <5fps	Q_{100} TW
Overtopping ≥100yr w/ debris problem and velocity ≥5fps	Q_{100} TW + 1'

PRESTRESSED CONCRETE BEAM GRAPH



Pre-Cast Rectangular Beams

These beam bridges may be used on short span bridges requiring low profiles. They are an alternative to the slab span bridge.

The advantages of the rectangular beam bridge are:
reduced construction time
longer span lengths at minimized structure depths
at times, can reduce the number of substructure units
are appropriate where construction of falsework for a conventional slab span bridge would be difficult or unwanted

Please reference the current Mn/DOT PCB Graph for span lengths and beam spacing requirements. The available depths are 14", 18" and 22".

The Beam Design can be based on 7,500 psi initial and 9,000 psi final maximum concrete strengths. Strand size can be either 0.5 or 0.6, but the 0.6 often allows for the elimination of a beam line.

The low member elevation should be set at:

Overtopping <100yr w/ no debris problem or velocity <5fps	Overtopping TW
Overtopping <100yr w/ debris problem and velocity ≥5fps	Overtopping TW + 1'
Overtopping ≥100yr w/ no debris problem or velocity <5fps	Q_{100} TW
Overtopping ≥100yr w/ debris problem and velocity ≥5fps	Q_{100} TW + 1'

Set the minimum deck overhang beyond the edge of the fascia beam flange at 6 inches.

The maximum deck overhang (measured from centerline of fascia beam) should not exceed the smallest of the following values:

- Depth of Beam
- 40% of Lateral Beam Spacing

Timber Slab

Timber slab or panel bridges are used on small stream crossings. 1 or 3 spans with a maximum span length of about 25 feet, at this time, timber bridges are feasible for short- and medium-span structures.

Timber slab bridges are generally constructed with longitudinal nailed laminated planks. This superstructure is easy to fabricate and install. The planks are generally made from creosote-treated Douglas-fir timber.

The low member elevation should be set at:

Overtopping <100yr w/ no debris problem or velocity <5fps	Overtopping TW + 1'
Overtopping <100yr w/ debris problem and velocity ≥5fps	Overtopping TW + 2'
Overtopping ≥100yr w/ no debris problem or velocity <5fps	Q_{100} TW + 1'
Overtopping ≥100yr w/ debris problem and velocity ≥5fps	Q_{100} TW + 2'

Timber simple or continuous slab spans should be designed so that the deflections due to service live loads does not exceed 1/500 of the span.

The use of timber bridges is limited to low-volume roads. Timber bridges tend to deteriorate faster if subjected to high repetitions of heavy loads. Their cost effectiveness should always be evaluated for each site.

Because of timber piling performance problems (pier piles breaking, decay and rotting), steel piling is being used for all substructures.

Double T Beam Span

This is our policy on the use of double tee bridges. As always we do not allow them on the Trunk Highway, however, we do allow them on our local road system as long as the following conditions are met:

- Low ADT
- Low or no deicing salts used on bridge.
- Flat grades
- Square bridge is preferred
- Low member is at least one foot above design flood, allow for two feet of free board if there are known debris problems.
- The bridge structure should be cost competitive with other bridge structures.

The low member elevation should be set at:

Overtopping <100yr w/ no debris problem or velocity <5fps	Overtopping TW + 1'
Overtopping <100yr w/ debris problem and velocity ≥5fps	Overtopping TW + 2'

Overtopping ≥100yr w/ no debris problem or velocity <5fps	Q_{100} TW + 1'
Overtopping ≥100yr w/ debris problem and velocity ≥5fps	Q_{100} TW + 2'

Steel Continuous Spans

Should be considered on curved alignments. Usually the best choice for spans over 145 feet. Steel continuous spans may be advantageous in regions of the state with poor foundation soils, and where significant substructure movement is anticipated.

Structure Types:

Span	Structure Type
Less than 50 ft.	Rolled beam
Between 50 and 120 ft.	Gray area (can use either rolled or plate girder)
Over 120 ft	Plate girder

Rolled beams may be difficult to obtain in lengths over 90 feet.

Constant plate girder depths can span up to 350 feet. Haunches are efficient over 350 feet.

Girders can be spaced at 10 foot intervals for spans in the 180-foot range. Maximizing girder spacing generally results in cheaper bridges. The cost effectiveness should always be evaluated for each site.

Set the minimum deck overhang beyond the edge of the fascia beam flange at 6 inches. The maximum overhang (measured from centerline of fascia beam) should not exceed the smallest of the following three values:

- Depth of beam
- 40% of lateral beam spacing
- 32 inches plus 1/2 of the top flange width

The low member elevation should be set at:

Overtopping <100yr w/ no debris problem or velocity <5fps	Overtopping TW
Overtopping <100yr w/ debris problem and velocity ≥5fps	Overtopping TW + 1'
Overtopping ≥100yr w/ no debris problem or velocity <5fps	Q_{100} TW

Overtopping ≥100yr w/ debris problem and velocity ≥5fps	Q_{100} TW + 1'

Design methods used
- ASD
- LFD
- LRFD

Use structural steel only where it can be repainted safely and economically

Bridges will be reviewed in the preliminary stage to determine which bridges should be painted. Avoid details that are difficult to paint.

Weathering steel stains supports and rusts under continuous moisture or salt exposure and may not reach desired appearance in extremely dry climate. Paint weathering steel 1.5 times the beam depth from joints and bearing assemblies.

Concrete Slab Span Bridge

Preliminary Slab Thickness:

-Simple Span

Minimum slab depth (ft) = $1.2 * \left[\frac{S+10}{30}\right]$

-Continuous Spans (Constant Depth)

Minimum slab depth (ft)= $\frac{S+10}{30}$

-Continuous Spans (Variable Depth)

Minimum slab depth at pier (ft)= $1.33 * \left[\frac{S+10}{30}\right]$

Minimum slab depth at midspan (ft)= $0.8 * \left[\frac{S+10}{30}\right]$

Minimum haunch length L = $0.15 * S$

Notes:

- S is the length of the longest span (ft)
- Skew can be ignored for slab bridges with skew angles of 20º or less
- Increase slab thickness to satisfy shear requirements when skew angle exceeds 20º
- Slab type bridges should not be used for bridges with skew angles greater than 45º
- End spans should be approximately 80% of the center span length to balance moments and prevent uplift.

Overtopping <100yr w/ no debris problem or	Overtopping TW – 1'

velocity <5fps	
Overtopping <100yr w/ debris problem and velocity ≥5fps	Overtopping TW
Overtopping ≥100yr w/ no debris problem or velocity <5fps	Q_{100} TW – 1’
Overtopping ≥100yr w/ debris problem and velocity ≥5fps	Q_{100} TW