

**Deflection Calculation: Cast-In-Place Exposed Deck
VT - Richmond Truss**

First, look at the bare grid with wet concrete on it.

w = uniform load per foot = 71.1 lb/ft = 6.22 kips/ft
 l = beam spacing = 6.000 ft = 72 in.
 I = the moment of inertia = 1.1007 in⁴ for steel grid only
 E = modulus of elasticity of steel = 29,000 ksi

A. Maximum deflection for a simple span is given by: $\frac{5wl^4}{384EI}$
 Deflection = 0.060 inches

B. Maximum deflection for a continuous span is given by: $0.0069 \frac{wl^4}{EI}$

The constant = 0.0069 from AISC LFD 2nd Edition, page 4-232 for a 3 span continuous uniformly loaded beam, which is the worst case. For 4 spans, = 0.0065 on page 4-233. By analysis, = 0.0062 for 2 spans, = 0.0067 for 5 spans, = 0.0064 for 6 spans, and = 0.0069 for more than 6 spans.

Deflection = 0.032 inches

FOR THE COMPLETED UNSHORED, CIP DECK:

LIVELOAD For the completed deck, deflection due to vehicular live load and impact is given by:

$$\frac{Pl^3}{48EI} \quad (\text{Simple Span})$$

P = 22.25 wheel load plus 0.5 impact force = 25 kips
 l = deckbeam spacing = 6.000 ft = 72 in.
 I = the moment of inertia

For the completed deck (grid and reinforced concrete), the moment of inertia is 31.8876 in⁴, but I = the moment of inertia of the width of deck that is effective.

We'll use AASHTO 3.24.3.2, which gives effective width as (4+0.6S), with a maximum of 7', where S is the span.

So, effective width = 4.36 feet, and the moment of inertia to use in the equation = effective width times I for a one foot width as given above.

$$= 4.36 \text{ ft} \times 31.887 \text{ in}^4 = 139.029 \text{ in}^4$$

If the Live Load is Pedestrian however, the load is generally 85 PSF and deflection is given by:

$\frac{5wl^4}{384EI}$ = uniform load per foot = 85 lb/ft = 7.083333 kips/ft
 l = beam spacing = 72 in.
 I = the moment of inertia = 31.8876 in⁴
 E = modulus of elasticity of steel = 29,000 ksi

DISPLCT_{max} due to live load (vehicle or pedestrian) & impact for vehicle loads = 0.05013 in. = 1/20 1/3 DLK

BUT THIS IS FOR A SIMPLE SPAN. For two continuous spans:

$$\text{Vehicle DISPLCT}_{\text{max}} = 0.0127 \frac{Pl^3}{EI} = 0.0061 \text{ in.} = 1/16 \text{ DLK}$$

$$\text{or Pedestrian DISPLCT}_{\text{max}} = 0.0009 \frac{wl^4}{EI} = 0.0009 \text{ in.}$$

Notes: An Exposed deck is very stiff. The section is deep, with materials (steel grid, concrete, and rebar) located where they can do the most good. When the deck is continuous over supports, the stiffness in positive moment areas (i.e. between supports) is further enhanced. Laboratory tests of Exposed decks at Lehigh and West Virginia Universities included deflection measurements during the course of external fatigue testing. At West Virginia University, for example, the 6'0" wide deck panels tested were relatively light, with 3" structural T's as main bearing bars, located on 12" centers. 4" of reinforced concrete was used. At a 6'0" span between supports, measured deflection was 0.116", or 1.863. Loading was HS-20 (20 kips including 25% impact). The calculated transformed moment of inertia for this module was 32.31 in⁴. Following the calculations above yields a calculated deflection of 0.1422 inches, or 1.802.