

MEMO

To: John Buswell, Roadway Structures Manager, SDOT

From: JH Clark

Date: 30 September 2013

Subject: WSB I Soffit Cracks

Cause of the Cracks: The symmetrical location and nature of the cracks would seem to preclude a random event (i.e. live load). Several causative mechanism can be postulated which would increase the global positive moment at the observed location. These include:

- Creep could be different than assumed in design. The use of a single number to describe the creep behavior is a gross simplification of a very complicated phenomena. Creep and shrinkage take a long time for full development in thick sections such as is present in this structure. The 30 year life time of this structure should have been adequate for almost full development. It should be noted that there is very little data on the creep of massive sections over such a time period.
- There is a statistical uncertainty in the actual structure dimensions (and thus dead load and section properties). Allowable form deflection under dead load is typically taken as 1/500 of the span. A figure of 2 to 5% is a reasonable upper bound estimate for this. The Pasco-Kennewick cable stayed bridge was constructed of precast segments cast in ground supported steel forms. Measurement of the displacement of the barges when these segments were loaded out for erection indicated about 3% more than the weight calculated from plan dimensions. Unit weight of the concrete also has some variability.
- The “hanging back” reinforcement at the bottom slab PT (6 #7 x 8'-0”) terminates at the point where the cracks occur (approximately 5' towards the pier from the joint). This sudden reduction of reinforcing from the normal bottom slab mild steel reinforcement (#5 at 12" top and bottom) plus these bars to only the normal reinforcement is a reduction in the local percentage of reinforcement from 2.6% to 0.44%.
- Differential temperature through the depth of the section could produce positive moment for events where the deck is colder than the soffit such as a sudden rain shower on a hot day.
- A seismic event producing significant longitudinal movement would produce positive moment

I do not consider it worthwhile to attempt to quantify the contribution of each of these factors. There are so many unknowns in the various inputs that the results are suspect. The cracks do not cause decrease in the longitudinal the load carrying capacity of the structure. It would function with a hinge at this location. The cracking does influence long term durability and potential reinforcing bar corrosion. Indications from the U-bit inspection are that at least some of the cracks are “working” cracks. There is at present no evidence that the cracks penetrate the full depth of the soffit although it was noted that they do continue up the web as inclined cracks.

Further investigation is warranted to determine whether the cracks do penetrate the full depth of the soffit slab. The first step would be to carefully examine the interior of the box using water to help reveal any cracks. The second step would be to core the slab in the area of the cracks to determine the depth of penetration. Strain gages placed across cracks could be used to find out whether cracks are moving and/or growing.

Repair procedures include epoxy injection of cracks, removing delaminated cover concrete (if any) and replacing with shotcrete, and finally reinforcing with carbon fiber strips. One difficulty to be overcome with carbon fiber strips is the fact that the soffit is concave and thus it would be difficult to provide initial tension and a good bond. The angle point at each joint in this area is approximately 0.01164 radians (from plan dimensions). This creates a force directed downward as the strip is tensioned. Perhaps it would be possible to resist this with a transverse steel strip anchored to the soffit.

In summary, the carbon fiber strips would be a last resort, expensive and difficult to effectively install.