Proposed Amendment to the AASHTO Fatigue Tests for Modular Expansion Joints

Presented To
The AASHTO Subcommittee on Bridges and Structures
T-2 Technical Committee on Bearings and Expansion Joint Systems

Watson Bowman Acme Corp.
Prepared by:
Dr. Paul Bradford, Ph.D.
Steve Pabst, Director of Sales
1. CURRENT AND ACCEPTED LIFE CYCLE FATIGUE TEST CRITERIA

2. FULL SCALE TESTING OF MODULAR JOINT SYSTEM SPECIMEN

3. SUGGESTIONS FOR TESTING OF MODULAR JOINT SYSTEM COMPONENTS
AASHTO LRFD Construction Specifications

Section 19 Fatigue Test:  *Current full scale test protocol*

- System fatigue testing for steel (metal) component connections.
- Joint placed on a 20% slope to produce a 20% horizontal load.
- Strains measured at strain gage locations, nominal stress calculated at the details of interest (e.g. connections).
- Higher than design loads are applied and cycled until the connection fails, or until the test is terminated.
- Number of cycles at failure \((N)\) and stress \((S)\) charted, 10 samples are required to identify the design fatigue category (usually \(C\) or \(B\)).
Illustration of 20% gradient load application to Simulate horizontal and vertical loads

Figure 6—Typical Fixture Used to Apply Load to Centerbeam

Horizontal Plane
Bevelled Plate to Allow Application of Vertical and Horizontal Loads
Centerbeam
Keeper Plate
The current test protocol has worked well. However there are shortcomings...

1. Owner/Specifier Feedback – Test stresses are much higher than design, many connection failures occur at less than 1 million cycles. As an illustration, how do we know that even if the stresses are much lower that the connection won’t fail at an elevated test of up to 50 million cycles”

2. Manufacturer Observations – Current life cycle fatigue test protocol suggests component revisions or detail improvements will subject manufacturers to onerous costs associated with full scale system re-testing.
Proposed modification to current standard

1. Maintain current requirements of full scale manufacturer system testing:
   “No change or revision to current full scale fatigue testing specification requirements.”

2. Addenda for component redesign or modifications:
   “If a system has successfully passed full scale system fatigue testing. Manufacturer component design modifications may be supported and meet current requirements with supplementary subsystem or component only fatigue tests.”
Examples:
- Eliminating a weld by using a single piece yoke
- Changing the weld process
- Changes in geometry of steel components
- Using standard fatigue connection details already covered by AASHTO
- Project specific requirements
Sample size per component: 4
Number of cycles: 7 million

**WHY 7 MILLION CYCLES?**

- The number of 7 million cycles is based upon the assumption that connections will achieve at least a category D rated connection. Hence every test run will exceed the theoretical infinite life cycle count for Categories B, B’, C, C’, and D per AASHTO Figure C6.6.1.2.5-1. The approach is different in that no attempt is made to establish an SN curve, rather the CAFT is met. The number of cycles is large, but because it is intended for all tests to exceed the run out cycle count, the number of samples tested is reduced from 10 to 4.
Figure C6.6.1.2.5-1—Stress Range Versus Number of Cycles
Suggested Provisions for Component Testing

- Tests are to be designed such that the geometry of the component and near the component is the same as that being used on the project
- Specimens are to be full size
- Geometry away from the component being tested may be modified to assist with test fixturing
- Loads shall produce similar stress ranges at the detail as expected in the field

Component Fatigue Test Concept Sketch
(for discussion purposes only, actual test setup may vary)
Current AASHTO specifications do not address the situation of variations to connection details on previously tested systems. WBA proposes to append the current specifications with a section allowing for subsystem testing. The subsystem test approach is a different approach, high cycle counts at service level loads that more closely represent actual loads. This is in contrast to the system tests that incorporate lower cycle counts with higher loads. It is anticipated that lower loads and simpler fixturing allow for high frequency testing, resulting in reduced test time and costs.