

## Description of Work

### ***Task 5.2: Topical Investigations on Joining and Inspection***

#### **Sub-Task 5.2.6 – Establish weld acceptance criteria considering intended uses, configuration, material properties, procedures and the reliability of available inspection procedures.**

##### **Background**

*Please see the attached document “Overview of Topical Investigations on Joining and Inspection” for the technical background to this sub-task and the relationship between this sub-task and the other Joining and Inspection sub-tasks and the overall Phase 2 project.*

##### **Objectives of Sub-task 5.2.6**

Develop weld acceptance criteria for seismic loading conditions, considering fitness for use for different performance expectations. Evaluate adequacy of currently accepted weld acceptance criteria (e.g., AWS D1.1 Structural Welding Code) for seismic loading and identify areas where these should be strengthened or relaxed in the development of the Seismic Design Criteria and Inspection Procedures documents to be formulated in the Phase 2 project.

##### **Description of Sub-task**

Present standards for acceptable weldments developed by AWS have proven to be appropriate for static loading conditions. Critical weldments that resist large seismic demands may require more stringent acceptance criteria to ensure proper performance. In other cases, current criteria intended to compensate for marginal weld quality variability may not be required if higher notch toughness material is utilized, or when only a few cycles of loading at the maximum deformation are required.

What constitutes an acceptable/rejectable weld is an issue of considerable professional discussion. Weld acceptance criteria are integrally related to the notch toughness of the weld region and base materials used, the constraint imposed on the weldment, the nature of the defects present that can be reliably identified with the inspection procedures used, and the expected condition of use (loading/deformation intensity, number of cycles of loading, rate of loading, etc.). Issues of dynamic loading have been raised which question the adequacy of acceptance criteria based on static tests and fatigue tests. Situations need to be considered where welds are expected primarily to transfer load (with limited plastic deformation capacity) as in a reinforced connection (or at a continuity plate), to be immediately adjacent to a beam flange that may have to undergo substantial inelastic deformations, or to directly participate in the overall yielding mechanism of the connection.

Efforts will be undertaken in this sub-task to synthesize, analyze and interpret data obtained from within the project, as well as from various methods in other codes and guidelines for establishing fitness for use criteria for welds. This information will be used to develop recommendations for consideration by the Guideline Writers related to selection of suitable materials, weld consumables and procedures and parameters, inspection methods and acceptance criteria considering the intended behavior of the weld during a seismic excitation.

## Scope of Work

To achieve the objectives of the subtask the sub-contractor is expected to develop and submit for approval to the Project Director for Topical Investigations a detailed Sub-task Work Plan addressing the objectives of the sub-task. It is anticipated that this Work Plan will include, among others, the following items:

1. The contractor must attend necessary meetings during the period of the sub-contract (e.g., project kickoff and quarterly team meetings with the Project Director of Topical Investigations and the Technical Advisory Panel). The sub-contractor is expected to provide regular verbal and written reports to the Team leader for Joining and Inspection and to the Project Director for Topical Investigations and be responsive to their requests related to the work.
2. The subcontractor is expected to work closely with the investigators involved with other activities within Task 5.2 as well as within Subtasks 5.1 and Task 7 to learn of all developments in the weld testing and data collection phase of the program. Similarly, activities undertaken in Subtask 5.3.1 and in Task 7 related to analytically computed demands on welded connections should be reviewed. The efforts in Task 3 to assess behavior of welded connections during the Northridge, Hyogo-ken Nanbu (Kobe) and other earthquakes should be reviewed and analyzed.

The subcontractor should also become familiar with the results of Task 5.4 related to the expected strain rates, deformation amplitudes and number of cycles of loading expected in typical welded moment-resisting joints. Information obtained in Task 3, 5 and 8 related to the likely reliability of various inspection methods should also be reviewed in formulating the recommendations to be developed in this sub-task.

3. Compare present U.S. and international structural welding codes to determine their major requirements with regards to seismically, dynamically and statically loaded structures. Special emphasis will be placed on codes containing fitness for use provisions. Evaluate adequacy of existing welding codes, including recommended or required consumables, qualification procedures, inspection requirements, and acceptance criteria, relative to seismic loading conditions and expected performance of welds in various types of connections.
6. Establish acceptance criteria with regards to weld and base metal quality, welding process, weldment metallurgical and mechanical properties (strength and impact properties), inspection procedure and defect characteristics (size, location, orientation, etc.).
8. Cooperate with Guideline Writers to incorporate into the Seismic Design Criteria and Inspection Procedure documents acceptance criteria and other relevant information on welding procedure suitability for seismically loaded structures.
9. Submit regular progress reports and updates at intervals to be defined during organizational meetings.
10. Prepare and revise a final report detailing the synthesis and analysis of available data and code criteria, recommendations for improved welding consumables, procedures, parameters and conditions, and for acceptance criteria considering different performance expectations. The report will be prepared according to format guidelines specified by SAC.

## Deliverables

Subcontractor will have the following as deliverables:

1. Revised and detailed work plan based on discussions during project kick-off meeting.
2. Weld acceptance criteria with regards to consumable and base metal quality.
3. Weld acceptance criteria with regards to welding process parameters and control.

4. Weld acceptance criteria with regards to weldment metallurgical and mechanical properties.
5. Weld acceptance criteria with regards to inspection procedure and defect characteristics.
6. Draft weld acceptance criteria document to be submitted to AWS for consideration by the AWS D1.1 Structural Welding Code for adoption and incorporation.
7. Regular progress reports and updates.
8. Final report.

#### **Task Management and Review**

This subtask is supervised by James Malley, Project Director for Topical Investigations. The Joining and Inspection Technical Advisory Panel (TAP) will provide oversight and an advisory role on the conduct of the research and will review and evaluate reports and recommendations. The Team Leaders and selected members of the Materials and Fracture TAP and the Connection Performance TAP, as well as the Guideline Writers for In-Process Inspection, New Construction, and Repair will also review and evaluate this work. It is expected that the subcontractor/consultant selected for this task will be responsive to issues and concerns raised by the Project Director, TAP and other reviewers.

#### **Target Audience**

The work products of this task will be directly used by consultants and sub-contractors working on the SAC Phase 2 project. The general results and the interpretation of these results will be of particular interest to Topical Investigation Team Leaders for Materials and Fracture and Connection Performance, as well as Guideline Writers and other general users. The information developed in this task will be incorporated into the State-of-the-Art report on Joining and Inspection, and will form the basis for many of the Guidelines for in-process inspection and non-destructive evaluation to be developed in Task 8 of the project. The work products will also be of interest to practicing building inspectors, building officials, and developers and end-users of inspection and non-destructive testing equipment in the steel construction industry.