One Engineer's Opinion

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Q. *In large high strength bolted connections consisting of heavy plates, good fit-up is often impossible to obtain by a snug tight bolt. In using the turn-of-the-nut method, where it is necessary to retorque centrally located bolts, how much additional turn is necessary after the prescribed turn?*

A. Paragraphs 5.c and 5.d of the *Specification for Structural Joints Using A325 or A490 Bolts* take this situation into account. For calibrated wrench tightening, the wrench must be re-turned to "touch up" bolts previously tightened which may have been loosened by the subsequent tightening of bolts. For turn-of-nut tightening, enough bolts must be installed and brought to "snug tight" condition to insure that the parts of the joint are brought into full contact with each other.

In the case of small joints or joints fabricated of flat material, only a few bolts may be required to compact the joint. In the case of large joints of thick material or many plies of material which are not flat, gradual tightening of bolts in virtually all holes may be required to compact the joint. Tightening should proceed in some orderly manner so as not to overstress any fasteners in an attempt to compact the joint by means of tightening only a few of the bolts. After the joint has been compacted by the required number of approximately "snug tight" bolts, the joint should be tightened to its final prescribed amount by applying the additional amount of nut rotation specified in Table 4 of the specification, with tightening progressing systematically from the most rigid part of the joint to its free edge.

The best results will not be achieved by over-torquing a few bolts at the center of the joint, hoping that the over-torqued bolts will be relieved to a proper degree by the tightening of adjacent bolts. Better results will be achieved to "squeezing the air out" of the joint by tightening as many bolts as necessary to the "snug tight" condition. With such procedure, admittedly more talent, experience and good workmanship is required of bolting crews assigned to the task of making up such heavy joints, but it should not be necessary for a crew to return to a joint once they have completed their work.

Q. *Are composite steel-concrete floor systems in buildings subject to time-dependent deflections due to shrinkage and creep of the concrete? How serious is this problem?*

A. Reference to the last paragraph on page 2-91 of the AISC *Manual of Steel Construction*, and to Paragraph 909(d) of the ACI *Standard Building Code Requirements for Reinforced Concrete*, provide the key to an answer to this question.

In the case of a steel-concrete composite beam, 50 percent reduction in assumed effective area of concrete results in a reduction in the moment of inertia of the composite section of only 10 to 15 percent. In general, as creep takes place in a composite beam, an increasing portion of the load is transferred to the steel beam. If such a phenomenon continued to extremes—which, of course, it will not—there would still remain the bare steel beam available to carry the load. Thus, the maximum deflection that could ever be observed would be the deflection associated with the steel beam alone—that is, 10 to 15 percent greater than the calculated deflection for the full composite section.

The Joint ACI-ASCE Committee on Composite Construction recommended that the effects of creep due to long-term loading be provided for by increasing the value of n. Similar results would be achieved by following Paragraph 909(d) of the ACI code.

In short, the deflection due to long-term loading and creep or shrinkage in the concrete is not as serious a problem in the case of composite steel-concrete construction as it is in the case of conventional reinforced concrete T-beam construction. Rules which have proved satisfactory for reinforced concrete construction are undoubtedly conservative for composite construction, since the steel beam is available to accept an increasing share of the load should the concrete compression flange tend to creep and become less effective.

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