Monitoring and Advising on Lave Villa Bridge

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During the last few years the new 70-ksi yield strength grade structural steel developed by ITI (NUCu-70W high performance steel now covered by ASTM A710 Grade B specification) achieved successful complete commercial application. It was used for the girders in a new bridge in Northern Illinois. Construction was almost fully completed in 2005, the girders are fully installed and half of the bridge is open to traffic. The advantages of ITI's 70-Ksi-yield steel over other structural steels of this strength level are many as listed below:

1. Simple processing - Air cooled from hot rolling not quenched and tempered
2. Easy to weld – No brittle heat affected zone in steel adjacent to weld
3. Increased resistance to weathering
4. Higher Charpy Impact Energy

The easier welding and better weathering characteristics are of particular interest. NUCu steel is welded without pre-heat or post-heat. It also has the best weathering resistance of any structural steel available and doesn't require painting giving a substantial cost savings.

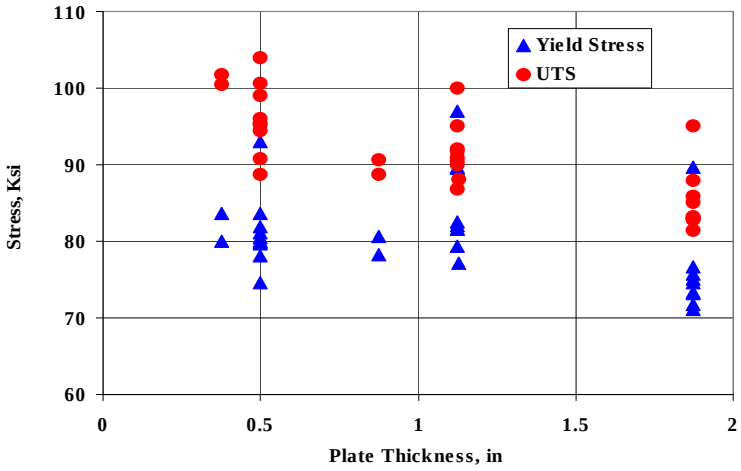
As a demonstration project the Illinois Department of Transportation specified NUCu 70W steel (A710 Grade B) steel for construction of a bridge near Lake Villa, Lake County, IL over railroad tracks on US 83. For this bridge following our specifications five 100-ton heats of steel were melted, cast and hot rolled in February 2005 by International Steel Group (now Mittal Steel) in Coatesville, Pennsylvania. The plates varied in thickness from 3/8 to 1 3/4 inch in thickness. The mechanical properties of the steel plates exceeded those required by ASTM standards for 70 Ksi yield strength grade bridge steels. Figure 2a shows that yield stresses of all of the plates exceeded the required 70 Ksi for all of the thicknesses. Some plates approached 100 Ksi yield strength. The Charpy absorbed impact energy of all plates at -10^{o}F significantly exceeded the 35 ft-lb minimum value required by the ASTM standard (Figure 2b). Most of the plates gave approximately 150 ft-lb values.

The as hot rolled plates were welded into girders for the bridge at Industrial Steel Construction, Inc. (ISC). Welding process qualification tests were passed without preheating or post heating and the plates were welded into girders without post or pre heating. In the welding the standard LA85/MIL800-HP-Ni welding rods were used. Actual welding of a girder is shown in Figure 2.

After the plates were welded together into girders holes were drilled for easy assembly at the construction site (Figure 3). According to ISC personnel the drilling of NUCu-70W (A710 Grade B) steel was not more difficult than drilling of lower strength construction steels. This observation confirmed the results of a study of three construction steels (A36, A709 and our A710 Grade B) "Determining the Machinability of High Performance Steels" performed by Machining Research Inc. under IDOT funding. In this study our "A710B steel gave consistently lower roughness readings (smoother finishes) over the entire range of feed rates…" than the other steels.

The welded girders were then shipped to the Lake Villa bridge site and bolted into place. Photographs of this process are shown in Fig. 4. The completed bridge is depicted in Fig. 5.

(a)



(b)

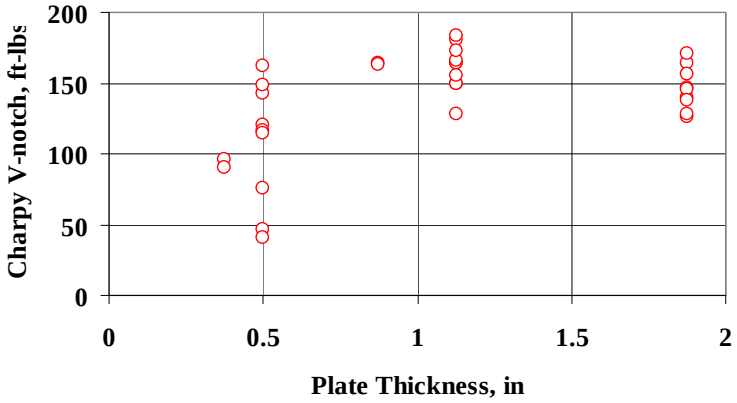


Figure 1. Mechanical properties of A710 Grade B steel used in the Lake Villa, Lake County, IL bridge as a function of plate thickness

Figure 2. Welding of girders for the Lake Villa bridge at Industrial Steel Construction,

Figure 3. Holes are drilled in girders

The bridge was assembled at Lake Villa, Illinois by Dunnet Bay Construction. Since the steel possesses exceptional weathering characteristics, the bridge was not painted, resulting in significant savings in construction (appr. $300,000) and future maintenance cost. Use of unpainted steel resulted in additional savings due to easy handling during shipping and assembly; painted girders are easily scratched during construction and requires labor-intensive paint touch-up after assembly.

During this time period we worked with IDOT to specify the steel for the bridge, with International Steel Group to advise with steel production, with Industrial Steel Construction do advise on steel welding.

Also, during this time we contacted the Union Tank Car Company (UTLX) to offer the steel for tank car construction. The steel plates that remained from the bridge construction were purchased by UTLX for testing as potential future steel for tank cars that transport hazardous chemicals; A710 Grade B steel's high fracture toughness at low temperatures is a critical property sought for tank-car applications. In initial tests performed to tank-car industry specification at UTLX (financed by American Railroad Association, UTLX and Dow Chemical) our steel significantly outperformed all other steels included into the program.

The construction of the bridge in Lake Villa attracted significant media attention. A number of articles appeared in local (Chicago Tribune, Daily Herald, Crain Chicago Business), national and international press and internet. We were asked to provide information about A710 Grade B steel for MatWeb, the source for materials information on internet. We made presentations at ASM and ASCE local chapters. We published papers together with IDOT representatives and bridge fabricator about the bridge fabrication and assembly. We prepared a brochure describing properties of A710 Grade B steel and its use in Lake Villa Bridge. Also, we

made a presentation jointly with C. Hybinette of UTLX at an international tank-car symposium reporting the results of steel testing in tank-car program.

Figure 4. Photographs taken during fastening of the steel girders to the concrete supports of the bridge

Figure 5. The finished bridge in Lake Villa, Illinois