Siena Footbridge

Completed in 2006, this stainless steel cable stayed footbridge spans 60 m over a busy motorway in the suburb of Ruffolo, Siena, in central Italy. The bridge girders and pylons are fabricated from a 'lean' duplex grade of stainless steel and it is one of the first times this grade has been used for a footbridge. The bridge has a striking appearance, is functionally efficient and cost-effective with a low life cycle cost.

Material Selection

The City of Siena required an attractive pedestrian crossing to be constructed over the motorway in the suburb of Ruffolo. The structure needed to have a 120 year design life without expensive and disruptive maintenance requirements. The architect selected the 'lean' stainless steel duplex grade 1.4162 (S32101) for the girders and pylons of the bridge. Lean duplexes have a very low nickel content (1.5 % compared to >3 % in standard duplex stainless steels), which results in significant cost benefits compared to other austenitic and duplex grades. This grade of stainless steel also experiences less price volatility because of the low nickel content.

The corrosion resistance of 1.4162, which lies between that of austenitic grades 1.4301 (S30400) and 1.4404 (S31603), is adequate for Ruffolo's benign inland environment with relatively low pollution levels. Grade 1.4162 has high strength (450 N/mm^2), good ductility (at least 30 %) and good formability and weldability. The high strength enables reductions in section sizes, relative to carbon steel sections, leading to lighter structures. This grade has tremendous potential for future structural applications. The surface finish on the hot rolled plate was specified as 1D, which is a standard mill finish with a dull appearance [1]. (This is equivalent to a No. 1 finish to ASTM A480.)

Figure 1: Pedestrian view of the completed bridge

Design

The bridge provides a 2 m wide footway over the motorway in a single 60 m long span. The reinforced concrete deck slab is supported on two 500 mm deep longitudinal beams, which act compositely with the slab. At each end of the span, 12 m high, inclined and inverted Y shaped pylons support the span by means of solid bar stays. Transverse beams and cantilevers for attaching the stays are provided at the four anchorage positions in the span. The main girders are each made from three plates (two flanges and a web); the thin web is stiffened transversely. The pylons are box sections, 400 × 600 mm in cross section. The fore and back stays are 60 and 70 mm thick respectively and are connected to a welded anchorage at the heads of the pylons.

All the structural steel in the main beams, transverse beams and pylons are of lean duplex grade 1.4162 steel. The stays were made from grade 1.4462 (S32205) duplex stainless steel bars (bars of the required size were not available in grade 1.4162). The walkway is enclosed by 2.5 m high mesh panels supported on extensions of the handrail posts. Handrails, posts and mesh were all of stainless steel.

Fabrication and Erection

The hot rolled duplex plates were produced in Degerfors, Sweden and transported to a plate service centre in Solbiate Olona, Italy. The plates were then plasma cut and the edges prepared for welding. The beams and pylons were fabricated in large sections and then delivered to the site. The paired main girders were lifted into place as a single unit and the stays connected. Precast deck panels were placed on the main girders and the pockets in the panels (around the shear connectors) were concreted. This type of assembly made the on-site erection work and processes easier and minimised the impact of the construction on the surroundings, both of which cut costs.

Figure 2: Underside of bridge, showing longitudinal and transverse beams supporting the deck

Grade 1.4162 has good weldability and can be welded by the same processes used for other duplex steels [2]. The restrictions in arc energy are less tight than for conventional duplex steels due to the grade's low alloy content and high nitrogen level.

Figure 3: Highway view of the completed bridge

Figure 4: Welded joint on pylon

Information for this case study was kindly provided by Anders Finnås (Degerfors) & Leroy Gardner (London).

References and Bibliography

[1] EN 100088-4:2009 Stainless steels. Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes

[2] Practical guidelines for the fabrication of duplex stainless steels, International Molybdenum Association, 2001 (*new Edition 2009*)

Online Information Centre for Stainless Steel in Construction:
www.stainlessconstruction.com

Procurement Details

Client:	City of Siena
Architect:	Seteco Ingegneria s. r. l
Structural Engineer:	Seteco Ingegneria s. r. l
Main contractor:	MMI

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