



# Anaco Stainless

Experts in stainless steel for engineering and construction

## Welsh Engineers Design Durable Bridges

Stainless steel, as a form of reinforcement in concrete, is becoming recognized as a robust response to corrosion related damage in reinforced concrete structures.

Numerous articles have now been written on its historic performance – some of which are referenced in this article. It is a forgiving form of reinforcement.

This article describes why Carmarthenshire County Council Technical Services made the decision to dispense with carbon steel reinforcement and other short to medium-term composite alternatives. The decision was made to spend more money upfront in order to avoid maintenance costs in the future.

Carmarthenshire CC is a large and mainly rural county with a significant number of bridges. To this extent, it is similar to North Yorkshire, a county which has already made the decision to use stainless reinforcement in remedial and replacement work to bridge structures.



Tucked away in a beautiful valley, Pont Twrch represents the cutting edge of the use of stainless steel reinforcement in bridge construction in Britain. The bridge spans the river Twrch which flows from the nearby Cambrian Mountains. The river is torrential in the flood seasons. It is also an environmentally sensitive salmon river. Contrary to the old structure, the new one incorporates a series of small weirs as well as otter passage, dipper nest and bat roosts to compensate for natural loss of habit in the old bridge.

Humbly referred to as a 'road alignment' in a journal listing construction contracts, Pont Twrch involved the replacement of a three span composite masonry bridge structure with a single span reinforced concrete bridge with masonry facing. Indeed, the project involved the realignment of the road which is the A482 linking Lampeter with the arterial A40.

The contract was awarded in March 2002 to a respected regional family-owned firm T Richard Jones.

### Factors Determining Use of Stainless Steel Reinforcement

As previously noted, Carmarthenshire has a large stock of rural bridges. The County's maintenance program is substantial and, where new structures have to be built,

consideration for methods of minimising future maintenance takes priority.

The Engineers wished to avoid what they have described as a 15 year maintenance cycle when using carbon steel reinforcement. The argument, simply put, is why devote precious resources to maintenance when these could be employed more responsibly to new infrastructure?

The evidence offered by the Progreso Pier, on the Yucatan Peninsula, is compelling. Commissioned in 1937 and completed in 1941, the Mexican Secretariat for Communications and Transportation wished to avoid future maintenance liability. The reinforcement used was stainless. Given the situation of the pier, the progressive and enlightened contractor (Christiani & Nielsen), choice was limited. Given the limitation of local resources, the contractor opted for local (highly saline) coral aggregate and used brackish (saline) water.

In its 60 year plus working life (to date), the pier has received no maintenance and shows no visible signs of deterioration<sup>2</sup>. The local environment of Progreso is characterized in terms of its aggressiveness as 'Category 5' on the International Organisation for Standardization ('ISO'), the highest rating achievable.



Although the Carmarthenshire climate is temperate, during the winter months road salts are still used to control icing. It is recognised that corrosion will be a real concern on all reinforced structures. This is a key reason for considering the use of stainless. It resists pitting in the presence of chloride ions.

Having established that maintenance needed to be minimised, the County Engineers' decision-making process was further influenced by the setting of the project. They recognised that access from the A40 to the site, close to Pumpsant, is tortuous and made consideration of precast 22m beams virtually impossible.

Given that a precast beam structure was at best impractical, an in situ reinforced concrete structure was adopted. A single

span arch design was agreed which was also sympathetic to its rural background. A similar structure further down stream had won an award for the County from the Royal Fine Arts Commission.

Soft ground conditions encouraged the design of a spread foundation using a raft design rather than employing piling methods.



### Subtitle Extensive Use of Stainless Reinforcement

It is recommended in the Highways Agency Advice Note BA84/02 that stainless reinforcement is used selectively: usage being limited to the splash zones, abutments, parapet edges and soffits and where the chances of chloride attack are greatest. Adherence to these guide lines can make the use of stainless reinforcement a marginal addition to the overall cost of the project.



The County Engineers departed from this guidance in determining to use stainless reinforcement throughout the structure.

This decision included the use of stainless steel in the raft slab of the bridge. It is generally considered that, where concrete is saturated and the movement of oxygen, an essential component in the corrosion cycle, is limited, stainless steel is not required. The Engineers considered that, due to the ferocity of seasonal flooding, the reinforcement was likely to be exposed on the raft by boulder impact during the life of the project. Exposure could mean earlier initiation of corrosion. The conclusion was, therefore, that with stainless, the raft slab and upstand beams' structural integrity and durability should not be compromised as a result of physical damage.

Other considerations influencing the County Engineers' decision fall in line with the conclusions underlying BA84/02. Among others, these involve exploiting stainless steel's corrosion resistant and mechanical qualities. Use of stainless reinforcement allows reduced concrete cover - 50mm to 30mm. This allowed for slimmer sections due to increased the lever arm and higher tensile qualities of stainless steel

versus high yield carbon steel. In line with BA84/02, a spray-on waterproof membrane was also specified. It is worth noting that BA84/02 requires the certification of the reinforcement by CARES - the UK Certification Authority for Reinforcing Steel<sup>4</sup>. This project was in the transition phase whilst stainless steel producers and processors make progress towards achieving CARES approval. Although the supplier has not yet been certified, CARES was asked to inspect the material on site.



The Engineers also took into consideration the forgiving qualities of stainless steel. The concern about accurate translation of what is designed and specified in an office to actual practice on site can lead, for example, to lower than expected cover. A non-corroding form of reinforcement absorbs such variations thus avoiding future maintenance concerns.

As has been proved by Progreso, the combination of stainless steel reinforcement and simple concrete is a perfect union of two inorganic materials. Carmarthenshire County Council has taken full advantage of this in a beautiful organic setting.



### Acknowledgements:

The author wishes to thank Messrs Trevor Sage, John Miller and Robert Evans of Carmarthenshire County Council Technical Services and Messrs Dafydd Jones and Aled Davies of T Richard Jones for their cooperation in the preparation of this article.

### REFERENCES:

- 1 Cochrane, D., Success for Stainless Steel. Concrete Mar. 2003
- 2 Castro-Borges, P., Knudsen, A., et al., Performance of a 60-Year-Old Concrete Pier with Stainless Steel Reinforcement. Materials Reinforcement Oct. 2002
- 3 Bowsher, B. and Brankley L., Developments in reinforcement supply. Concrete May 2002
- 4 The Highways Agency BA84/02