Innovation through research

by Tim Wilkinson and David Ryan

In the late 1980s, Australian structural tube manufacturers mills were using advances in hollow section rolling techniques and production of steel coil and were among the first in the world to have 450 MPa strength sections rolling off their mills. These sections were 30 percent stronger than the existing 350 MPa product.

Twenty years on Australia is still a world leader in the production of high strength cold-formed tubular sections. In these 20 years, the tube manufacturers and Australian researchers have worked together to demonstrate the structural performance of these steels and allow their inclusion in design standards.

Much of the research has been centred at Sydney and Monash Universities. Professor Greg Hancock, Dean of Engineering at Sydney University has been a significant figure in this development. Professor Hancock commented that: "the investigations performed have done much more than benefit the tube manufacturers and increased the competitiveness of steel construction. The people involved in these projects have received valuable research training which benefits them and society as a whole. At The University of Sydney, we have produced close to 10 PhD graduates in this field of cold formed high strength steels. They have gone onto bigger and better things in a wide spectrum of engineering and non-engineering fields."

One of these graduates is Xiao-Ling Zhao who became a Professor at Monash University in 2001. Xiao-Ling and his team have furthered investigations into aspects such as fatigue of welded connections, earthquake or fire resistance of unfilled and concrete-filled tubes, floor system utilising C450 tubes as bearers, joists and piers, and innovative ways to strengthen tubes using CFRP (carbon fibre reinforced polymer). Monash University has had six postgraduate students and one post-doctoral fellow working on projects related to C450 steel.

This investigation is required since high strength cold-formed steels have different material properties to traditional hot-rolled steels. Doctor Tim Wilkinson, from Sydney University explains: "Our structural engineering rules for structural steel design have been mainly based on the behaviour of hot-rolled I-shaped sections. Cold-formed steels have different yielding and ductility behaviour. This is not better or worse, just different. However, this means we need to reassess and recalculate our engineering design models where buckling, fatigue and welding is involved."

To help the structural engineering community understand the issues involved in cold-formed tubular design, Professors Zhao and Hancock and Doctor Wilkinson have recently published a book titled Cold-Formed Members and Connections: Structural Behaviour and Design. It is aimed at academic researchers and practitioners. The book deals with fundamental behaviour and and journeys into the research of tubular structures and how this has been used to form the design equations used today. Sample calculations are done to both the Australian Standard AS 4100 and the British Standard BS 5950. This recognises that many Australian engineers are performing work for Asian projects and the British Standard is often the rule of choice in the Asia-Pacific region.

The experiments performed have demonstrated many of the advantages of tubular products. For instance, Xiao-Ling's experiments on lateral buckling of RHS showed that much less bracing was needed. This can have significant cost savings in structures such as low rise industrial portal frames.

Comments from the Australian Steel Institute

The pioneering work undertaken in the 1980's as described above has substantial economic advantages to the Australian manufacturing industry. The C450 grade, coupled with its ability to satisfy AS 1163 Grade C350 allows distributors to stock just one product improving efficiency of stockholding. The C450 grade allows designers when they are not deflection limited to specify lighter gauges or smaller sections reducing construction costs.

This engineering efficiency coupled with the huge advances in coating technologies and welding research on in line galvanised tubes has seen a rapid take up of these innovative products and the ability to capitalise on this innovation overseas. This has been good for Australia and is a result of the partnership of Australian pipe and tube manufacturers with some very advanced and competent researchers in this country. Professor Greg Hancock has been instrumental in initially coordinating this cooperation and the ASI would like to acknowledge this effort along with that of his colleagues.

This article is submitted by researchers from The University of Sydney and Monash University and is recognition and acknowledgement of the pioneering work done by the research organisations in conjunction with the innovative pipe and tube producers in this country.