

Institution: Oxford Brookes University
Unit of Assessment: 15 - General Engineering
Title of case study: Performance investigation of light steel framing
<p>1. Summary of the impact (indicative maximum 100 words)</p> <p>As academic lead partner Professor Ogden and his team at Oxford Brookes University were responsible for a major research programme focusing on the development of light steel construction technology. Major industry funding in conjunction with EU support, facilitated a detailed understanding of the technology, and various demonstration projects including the then largest light steel framed building in Europe, constructed at Oxford Brookes University. The results of the work have been adopted by industry in order to innovate novel construction solutions. As a consequence light steel framing is now the favoured method of construction across the entire modular off-site buildings sector and in other mass market construction applications including site-built structural framing and infill walling. The value of the market that that has emerged in the UK during the census period is estimated to be £78 million per annum.</p>
<p>2. Underpinning research (indicative maximum 500 words)</p> <p>Since 1990 Oxford Brookes University has been involved in light steel framing research, with a formal strategic R&D arrangement being in place since 2002. Light steel framing relies on structural sections produced from thin cold formed galvanised steel strip. It is a basis for producing medium scale buildings and building elements efficiently. Research carried out at Brookes has been instrumental in establishing a proper technical understanding of the material including:</p> <ul style="list-style-type: none"> • Structural and mechanical properties, • Thermal and acoustic performance, • Fire resistance and durability. <p>Major applications now exist in the housing sector, key worker accommodation, student accommodation, schools, hotels, health care and MoD/MoJ accommodation, as well as specialist general applications such as infill walls and framing in commercial and industrial buildings. Through its 'Architectural Engineering' research group (based jointly within the Department of Mechanical Engineering and Mathematical Sciences and the School of Architecture) the University is a strategic research partner of Tata Steel Europe. A large amount of the underpinning research has been undertaken using direct industrial funding. Through this, the University has received approximately £1.25 million of support and hosts a Tata sponsored chair held by Professor Ogden.</p> <p>Early studies comprised theoretical work to predict the competitiveness and supply chain implications of light steel as a mainstream construction material, and identified the technical, structural and building physics research necessary to optimise performance and achieve efficient compliant solutions. This resulted in the generation of widely published and industry supported design data for light steel in the areas of building physics, durability and construction (led by Oxford Brookes University) and structural compliance (led by SCI with Oxford Brookes). This world leading information provided a basis for system developers to begin to offer products into commercial markets on a large scale e.g. Metsec's Metframe and British Steel's 'Surebuild' system.</p> <p>Subsequently, a major proposal for an international multi-partner project focusing on light steel construction, known as MegaProject 5: Steel in the Urban Environment was supported by the EU. Partner countries included UK, Finland, Sweden, Italy, Germany and France. Ogden led the overall portfolio of activities initially for housing and latterly also for the multi-occupancy (apartment) sector. These activities resulted in demonstration projects across the partner countries and the then largest light steel framed building in Europe being constructed at Oxford Brookes University (a three storey house and student hall of residence) together with a number of related full scale test buildings.</p> <p>The large scale demonstration project at Brookes underwent exhaustive testing and monitoring over a three year period. The building played an essential role in establishing grounded performance data. This was particularly important in areas such as building physics performance</p>

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(thermal and acoustic), where systems details are critical; and durability and corrosion resistance, which previously had been an area of systematic and premature failure due to poor detailing and lack of technical understanding. Complementary to this, full scale test buildings constructed in laboratories provided actual structural performance data which then allowed engineers to design beyond conservative structural code predictions. The work led to a sustained programme of research and development from 1997, which is still on-going in the context of advanced applications (e.g. high rise modular in excess of 7 stories). The research resulted in further technical outputs, (5-10), and further research grants (11).

Subsequent to EU MegaProject 5 and in parallel with its portfolio of funded research for Tata Steel, Oxford Brookes has provided applied research and development services to downstream industry in the area of light steel framing. It supported major investments from companies including Terrapin, Barratt, and Corus Living solutions, as well as overseas companies such as Posco in South Korea. It maintains a dedicated and intensively used structures and building physics laboratory. Examples of applied activities also include Ogden's buildings concept around which Unite Modular Solutions commissioned a major production facility in Gloucestershire able to produce three room modules per hour/6000 modules pa.

2. References to the research (indicative maximum of six references)

1. Industry Funding: Circa £1.2m in the period 2002–2013. Oxford Brookes Umbrella Research Agreement with Tata Steel. PI Prof. R G Ogden. 9.9.2002.
2. Grant: MegaProject 5: Steel in the Urban Environment. European Coal and Steel Community (ECSC). Contact ref: 7215-CA/808. Contract period 1.7.1994-31.12.1997. Project cost 837k Euro.
3. Demonstration Project: Light steel framed student accommodation building. Oxford Brookes University (John Garne Way) .1997. Lead industrial partners: British Steel ('Surebuild') and Taywood Homes.

Submitted to RAE2001, Oxford Brookes University, UoA33-Built Environment, RA2, RG Ogden, Output 2.

4. Grant: MegaProject 5: Valorisation Phase (Dissemination) Steel in Housing. European Coal and Steel Community (ECSC). Contact ref: 7215-PP/043. Contract period 1.7.1999-30.6.2001. Project cost 280K Euro.
5. Book: Building Design Using Cold Formed Steel Sections: Acoustic Insulation. Ogden, R. and Clough R., Steel Construction Institute, 1994. ISBN: 9781870004930
6. Refereed journal article: Steel in Housing as Part of ECSC Mega Project. Journal of Constructional Steel Research, Volume 46, No 1, 187-188, Ogden, R., Lawson, M. and Grubb, J, 1998. DOI:10.1016/S0143-974X(98)80016-3
7. Book: Steel in Multi-Storey Residential Buildings. Lawson, M., Ogden, R. and Rackham, J. The Steel Construction Institute, 2004. ISBN: 1859421547
8. Refereed journal article: Developments in prefabricated systems in light steel and modular construction. The Structural Engineer, Volume 83, No 6, Lawson, M., Ogden, R., Pedreschi, R., Grubb, J. and Popo-Ola, S. 2005.

Submitted to RAE2008, Oxford Brookes University, UoA31-Town and Country Planning, RA2, RG Ogden, Output 2.

9. Refereed journal article: Developments in Light Steel Composites in Floors and Roofs. The Structural Engineer, Volume 84, No 21. Lawson, M., Ogden, R., Pedreschi, R., Grubb, J. and Popo-Ola, S. 2006. <http://www.istructe.org/webtest/files/b1/b16d868b-b885-46c5-a29d-edd72ffaefb3.pdf>

Submitted to RAE2008, Oxford Brookes University, UoA31-Town and Country Planning, RA2, RG Ogden, Output 4.

10. Refereed journal article: Hybrid Light Steel Panel and Modular Systems. Thin Walled Structures, Volume 46, No 7-9, 720-730, Lawson, M. and Ogden, R., 2008. DOI: 10.1016/j.tws.2008.01.042

Submitted to REF2014, Oxford Brookes University, UoA15-General Engineering, REF2, RG Ogden, Output identifier 7812.

11. Grant: Demonstration of Modular Steel Construction in the Renovation of Multi-Storey Residential Buildings. European Coal and Steel Community (ECSC). Contact ref: 7215-

PP/010. Contract period 1.7.1997-31.12.2000. Project cost 1950K Euro.

4. Details of the impact (indicative maximum 750 words)

As lead academic partner, the world leading information generated by Ogden and his team at Oxford Brookes University has played a central role in developing and proving the merits of light steel technology. Various examples of publications and demonstration activities arising from the research are cited in section 3, however these represent a small proportion of the total industry accepted outputs. Projects such as the Oxford Brookes European MegaProject 5 demonstration building played not only a key role in developing the technology but also in creating awareness and understanding. The building received over 2000 visitors and gained extensive press coverage (circa 40 articles written between April 1997 and March 1998).

The developments have resulted in increased confidence in light steel technology:

- Companies have been prepared to commit to multi-million pound investment programmes to deliver products at commercial volumes based on the demonstrated technologies (e.g: Ayrshire, BW Industries, Fusion, Kingspan, Knauf, Lafarge, British Gypsum. Metsec).
- Specifiers have gained confidence in the performance of light steel framing such that they are willing to use it in preference to longer established but often less efficient alternatives.
- Building control agencies (such as local authorities, Lantac, NHBC etc.) have accepted that systems are free of unacceptable or abnormal levels of risk. Buildings based on the design practices that have been developed are considered equally by mortgage and funding companies to those constructed using conventional technologies such as masonry and timber.

The scale of impact of the research can in part be gauged by the major contribution that the market makes to the steel production sectors where the annual tonnage is over 1% of total UK output.

Other key measures include changes in construction markets:

- The market share of light steel framing is currently 17% overall and gaining on timber frame, currently 56% (a). In the permanent modular off-site buildings market, light steel framing has essentially taken over from timber to the extent that few timber framed modular companies remain.
- 28% of the total UK offsite construction market is attributed to permanent light steel modular buildings of the type addressed by the research, a further 9% to relocatable buildings (approximately 75% of which rely on light steel framing). The increasing efficiency of modular construction has meant that it has grown from a negligible amount in 2000 to a point where it is currently estimated to account for 2% of the total construction market (b).
- Based on annual sector surveys by the independent market research company 'Construction Markets' (c), the peak light steel framing market in the period 2008-2012 was 66K tonnes pa. Taking an average galvanised strip steel cost of £600 per tonne this equates to a materials market of £39.5 million pa. The contribution of this to the turnover of supply chain companies (assuming normal manufacturing overheads of 1.75 and margins of 12.5%) is circa. £78 million pa. to the UK economy.
- This use of domestically produced product is actively reducing timber imports, as conventional and pre-existing technologies require softwood sections not available in the UK. The effect on the UK trade balance is therefore significant.

It is important to recognise that this impact has been achieved in a recessionary period where the total construction market has been reduced by approximately 50% and where conventional costs are at their most competitive.

Impact may also be judged in terms of widely acknowledged cost, performance and efficiency benefits to the construction sector (examples of supporting material for this latter claim being given in section 5, refs d – g). Benefits include:

- Improved speed of construction with rapid reliable construction programmes.

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- Higher levels of automation reduce costs and reliance on specialist site trades.
- Improved quality with low levels of defect remediation required post construction and reliable in service performance.
- Improved environmental performance including low waste, good insulation and high levels of airtightness.

These benefits of light steel construction developed in the UK are also reflected in the international development of the technology. In part this is due to the improved resilience and robustness against earthquake and wind loading. Early adopters therefore include New Zealand, Australia, Japan, USA, Canada and South Africa (h).

The knowledge gained in relation to light steel within the team has also formed the foundations for commercial innovation, such as the creation of high reflectivity liner sheets which have been developed for built-up cladding systems. Launched in late 2012, these have sold 1000 tonnes by May 2013 value £600K.

5. Sources to corroborate the impact (indicative maximum of 10 references)

- a. Market research: www.amaresearch.co.uk/prefabricated_frame_panel_12s.html, as available 29/05/2013.
- b. Report: Offsite Production in the UK construction Industry. A Brief Overview. Taylor, S. Construction Engineering Specialist Team: Health and Safety Executive, 2009.
- c. Market research: Annual Independent statistics (2008-2012) compiled by 'Construction Markets Ltd'. Collins, D.J., 2012.
- d. Refereed journal article: Benefit evaluation for off-site production in Construction. Construction Management and Economics, Volume 24, No 2, 121-130. DOI: 10.1080/01446190500184444. Blismas, N., Pasquire, C. and Gibb, A., 2006.
- e. Report: Offsite Housing Review. Report funded by the Department of Business, Innovation & Skills and the Department for Communities & Local Government through the Construction Industry Council (CIC), with Oxford Brookes University and the University of Cambridge. Whitehouse, N. and Miles, J., 2013.
- f. Report: Buildoffsite Review 2012. The business case for offsite. Buildoffsite
- g. Report: Value and benefit assessment of light steel framing in housing. Rogan, AL and Lawson, RM, Steel Construction Institute, 1998.
- h. Journal article: Light steel framing at Steelfuture conference. Steel Construction, Volume 37, No 2, Barnard, J., 2013.

The following individuals may be consulted:

- i. Corroborating contact 1. Director of Strategic Marketing (responsible for all European business sectors), Tata Steel.
- j. Corroborating contact 2. Former Product and Market Development Manager (responsible for UK and EU market development within British Steel Strip Products).
- k. Corroborating contact 3. Former construction policy specialist.