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Citation for published version:

Pedreschi, R., Soden, J., Walker, P & Ansell, M 2012, *Woven Structural Formwork*. University of Bath: Limesnet. <http://limesnet.org/wp-content/uploads/2012/09/IMF003_finalLimesnetCase-study_Soden.pdf>

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

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Woven Structural Formwork

Mission Leader: Dr Julie Soden (University of Ulster)

Mission Partners: Professor Remo Pedreschi (University of Edinburgh), Professor Pete Walker and Dr Martin Ansell (University of Bath)

About this Case Study

The main objectives of the cross-disciplinary team were focused on the use of textile in construction, including:

- 1) use as the key load-bearing element within permanent fabric formworks;
- 2) reinforced natural fibre systems for building components;
- 3) applications of geo-textiles in large-scale infrastructure.

The objectives were discussed and developed with expert contributions and during a series of one or two-day meetings led to a dynamic exchange of knowledge and ideas. The team met with key experts in the various fields, Prof Mark West, C.A.S.T. University of Manitoba, Mercedes Alcock (product innovation team) at the Composites Innovation Centre, Winnipeg and Dr Richard Brachman of the Geo-Engineering Centre, Queens University Kingston. Visits were also made to the Alternative Village, University of Manitoba and Red River College, Manitoba. Discussions considered the need for enhanced structural performance through the emergence of new textile assemblages, improvement of disaster area infrastructure and how concrete, hemp-lime and other in-fill materials inform the process (and design) of construction, both practically and conceptually.

Fast Facts

- Using fabric formwork enables structurally efficient, custom shaped and aesthetically appealing concrete members to be formed.
- Lightweight textile formwork is suitable for concrete.
- Dewatering of fresh concrete during casting improves strength and durability of hardened material.
- Geotextiles suffer from elongation, buckling and rupture when stressed in buried containment infrastructure.
- A high performing Geotextile reduces amount of aggregate required.

About this Mission

The main objective of the mission was to discuss and assess the potential benefits for developing new, advanced textiles for formwork systems with a variety of in-fill materials, to improve construction efficiency and structural performance and durability. Building components such as columns, beams, vaults, panel products, natural fibre composites and moulded architectures were studied as exemplars of good practice. The mission team learned of their achievement and attributes in terms of fabrication, economy of process and structural performance and how these could be further enhanced using advanced textiles. Following the visit to the Geo-engineering Centre at Queens University Kingston, the improved design of buried geo-composite and geo-textile containment materials emerged as a focus applicable to the mission.

A two-day engagement with Prof Mark West and his team from the CAST Centre and architecture colleagues enabled a hands-on exchange with the mission team. Issues discussed included identifying the key characteristics and properties of a range of textile reinforcements, natural fibre performance, selection and variation of in-fill materials, impact

“From reinforced wall structures and conceptual formwork to new containment infrastructure, weaving is a key technology enabling new solutions to be realised for the built environment”



of formwork and geotextile required in the build process, and finally the design approach. Responding to requirements for material efficiency, improved integral strength and adapting established formwork techniques to produce larger scale span structures, new ideas for in-filled formwork through the use of load-bearing textile reinforcement evolved.

The mission team presented their individual research expertise (3D woven and load-bearing textile design, the properties and analysis of natural fibre composites, processes and methods in formwork concrete and sustainable building practices using straw-bale) with specific relevance to the mission topic. Discussions with the Composites Innovation Centre focused on test procedures for natural fibres and with the mission's textile focus, concentrated on the textile supply chain and material sourcing in North America, economical ways to improve the structural performance of non-woven natural fibre mats and the development of natural fibre composite products for dwellings.

The team also met with Dr Richard Brachman and Prof. Ian Moore from the Geo-engineering Centre at Queens University Kingston, who highlighted the performance shortcomings in geo-composite materials for underground containment structures that result in subsequent economic problems. The potential in an improved textile geo-composite solution was realised. The visit included a tour of the buried infrastructure test laboratory.

Benefits/Impacts of the Mission

The LimesNet funding was critical to bring the cross-disciplinary group of experts together. Approaching the topic from a materials (design) perspective generated debate about the use of 'ubiquitous' commercially available materials, the issues regarding the introduction of new materials and processes to the construction industry and the need to understand the client user group. Allied discussions revolved around the anthropology of dwellings, producing structures for the varied terrain and climatic conditions, and inhabitant behaviour. Other discussions brought in an interest of digital 'tagging' building materials and systems to record their design, construction and history.

There is a significant impact on non-research groups and a definite benefit to a wide range of inhabitants for the development of these new formwork materials, particularly in disaster relief areas, areas prone to flood, building on reclaimed land etc.

Outputs

- Mark West invited to attend the next fabric formwork workshop at the University of Edinburgh, along with the other members of the mission.
- Prototypes developed at Ulster (patent pending) to be used in trials at University of Edinburgh and University of Bath.
- Invited to submit collaborative research paper at Geotechnical Engineering Conference, Montreal, Canada 2013.
- Contact with Red River College will lead to proposals for some collaborative study projects.
- Potential contribution to new composite product for Alternative Village.
- Attracted a number of interested Industrial parties.

Follow up activities

- New directions in formwork design, geo-composite and reinforcing fibre structures for either feasibility study or full grant proposal status.
- The funding strategy to target collaborative AHRC / EPSRC initiatives with strategies to collaborate with International partners.
- Develop both short-term speculative research projects (with specific manufactured outcomes).
- Develop cross-discipline practical workshops for students to escalate the ideas and raise overall profile of the materials.
- Apply for funding an International PhD in a formwork related topic.
- Collaborative conference papers are planned once prototype and workshop outputs are complete.
- Continue to seek additional committed industrial and NGO humanitarian partners.

www.limesnet.org.

If you have any queries, comments or ideas about any aspect of LimesNet, please email limesnet@bath.ac.uk, or contact:

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