

THE
REGENERATIVE
STRUCTURE

The title is presented in a large, white, sans-serif font across four lines. The word 'THE' is smaller and positioned above the first line. The word 'REGENERATIVE' is split across two lines: 'REG' on the top line and 'ENER' on the second line. The word 'STRUCTURE' is split across two lines: 'STR' on the third line and 'UCTURE' on the fourth line. The letters are filled with white and have black outlines. The text is set against a light brown, textured background. Green botanical illustrations, including a flower, a leafy branch, and a fern, are integrated with the letters. Black architectural line drawings, including a window frame, a door frame, and a structural section, are also integrated with the letters. A solid green vertical bar is on the left side of the cover.

STRUCTURAL ENGINEER

OLIVER BROADBENT AND JAMES NORMAN

The
regenerative
structural
engineer



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The authors

OLIVER BROADBENT

1851 Fellow in Regenerative Design

Oliver has a diverse background — he studied Chemistry at The University of Oxford, Civil Engineering at Imperial College London, and worked as an engineer at Expedition. However, he quickly diversified again, helping to establish Think Up, the design education arm of the Useful Simple Trust^{0.1}. Alongside other initiatives, Think Up produced the highly influential *Embedding Sustainability in the Undergraduate Civil Engineering Curriculum*^{0.2} back in 2012 — when many organisations were just waking up to sustainability. A quick flick through the guidance now and you will spot, if you have any familiarity with the concepts of regenerative design, a number of regenerative ideas.



Oliver in the process of writing this book

In 2018 Oliver left Think Up to start his own company Constructivist^{0.3}. From here he has continued the conversation on sustainability, regenerative design, the climate and biodiversity emergency, and creativity. He has run training on what to do after declaring a climate emergency and continues to run training on both net-zero design and conceptual design with the Institution of Structural Engineers. In 2020, Oliver was honoured to receive the Sir Misha Black Award for Innovation in Design Education. In 2022 he established the Constructivist Regenerative Design Lab and later that year was appointed 1851 Fellow in Regenerative Design.

JAMES NORMAN
Professor of Sustainable Design



James in the process of writing this book

James has been a structural engineer all his life. He studied Civil Engineering at the University of Nottingham, joined Whitbybird in 2000, left to do a PhD at the University of Bristol in structural dynamics between 2003–6, and rejoined Whitbybird (who became Ramboll soon after) in 2006. James however, continued to teach structural design one day per week. In 2011 he started teaching a unit on sustainable

construction and in 2012 joined Integral Engineering Design to get more hands-on experience in sustainable design (including rammed earth, straw-bale, timber and reuse).

James has designed using a number of different materials including steel, concrete, timber, masonry, earth, straw and glass. He has worked on a wide variety of projects; from the façade of the Tate Modern extension to a small glass table at the Tate St Ives.

In 2015 James became a full time academic but continues to think and behave like a structural engineer. He teaches structural design to years 2–4 for half the year and during the other half he writes books and articles for structural engineers including *Conceptual design of buildings* (IStructE)^{0.4}, *Structural Timber Elements: A pre-scheme design guide* (BM TRADA)^{0.5} and *Designing timber structures: An introduction* (BM TRADA)^{0.6}. In 2020 James was awarded a National Teaching Fellowship and became Professor of Sustainable Design.

REFERENCES

- 0.1 Useful Simple Trust. *Purpose-driven design for our changing environment*. Available at: www.usefulsimple.co.uk [Accessed: December 2023].
- 0.2 Think Up. *Embedding sustainability in the undergraduate civil engineering curriculum*. Available at: <https://thinkup.org/reports/embedding-sustainability-in-the-undergraduate-civil-engineering-curriculum/> [Accessed: December 2023].
- 0.3 Constructivist. Available at: <https://constructivist.co.uk/> [Accessed: December 2023].
- 0.4 The Institution of Structural Engineers. *Conceptual design of buildings*. London: IStructE Ltd, 2020.
- 0.5 Norman J. *Structural Timber Elements: A pre-scheme design guide*. (2nd edition). High Wycombe: BM TRADA, 2017.
- 0.6 Norman J and Thompson A. *Designing timber structures: An introduction*. High Wycombe: BM TRADA, 2020.



Introduction

What if, in our work designing buildings, towns and cities, we could not only minimise harm to the environment but actively contribute to its healing and regeneration?

The concept of regenerative design started to gain prominence with built environment professionals in the UK around the time of the IPCC's *Special Report: Global Warming of 1.5°C*^{1,2} in 2018. That report triggered a growing realisation among people in the built environment sector, including many structural engineers, that despite striving for sustainability for more than 20 years, our industry was not doing enough to limit its impacts on the climate and on the ecosystem that supports life on Earth. Within the global structural engineering community, this realisation manifested itself in initiatives like 'UK Structural Engineers Declare a Climate & Biodiversity Emergency'^{1,2}, which had been signed by 270 structural engineering firms at the time of writing.

As our industry begins to confront the stark reality of climate breakdown and biodiversity loss, it becomes clear that a profound transformation is needed in the built environment sector. This transformation requires us to rethink not only our approach to individual projects but also how we organise our industry and the mindsets through which we see our work. The Structural Engineers Declare statement acknowledges that 'together with our clients, we will need to commission, design and build cities and infrastructure as indivisible components of larger, constantly regenerating and self-sustaining systems in balance with the natural world'.

Embracing this approach to design will require us to move away from a model of continuous growth towards a more holistic one. Design recognising that everything we produce is part of a wider living system that must remain in balance. Design that not only repairs the damage done to our climate and ecosystems but that enables all life, humans included, to flourish. In other words, an approach to design that is **regenerative**.

The goal of regenerative design is for human and living systems to survive, thrive and co-evolve^{1,3}.

But what does a regenerative approach to design look like in reality? How is it different from the sustainability approaches that we have been taking so far and what role should structural engineers play? As the term ‘regenerative’ gains traction, it is becoming increasingly important to ask these questions, both so we can make the most of what this regenerative framing offers, and so that we can avoid the term becoming subverted into marketing jargon.

ABOUT THIS BOOK

Split into four parts, this book explores what it means to be a regenerative structural engineer. By asking this question we aim to provide purpose and motivation for structural engineers at all stages in their careers as they think about the role they can play in responding to the climate and biodiversity emergency.

At the same time, we acknowledge that not all engineers may feel the relevance of regenerative design in their daily work. But while it may not be expressed in such terms, we predict that as the climate and biodiversity emergency deepens, more and more clients will be asking design teams to respond to complex questions about our wider ecological impact as well as our carbon impact. Our intention is that

this exploration of regenerative structural engineering can provide a framing that helps answer these questions.

Here is a summary of the content that follows:

Part 1 (Chapters 2–3): Introducing regenerative thinking

- Exploring regenerative design through a systems lens
- How regenerative design goes beyond sustainable design
- Plotting a path from our current way of working to a regenerative industry
- Taking inspiration from thriving living systems for how we should be designing

Part 2 (Chapters 4–6): Creating the transition

- How can we design our projects more regeneratively?
- How can we enable the industry to operate more regeneratively?
- How can we enable engineers to think more regeneratively?

Part 3 (Chapters 7–9): Becoming regenerative

- How can we create and sustain regenerative practice?
- The role of the regenerative structural engineer
- Practicing place-based continuous design (and an artefact from the future)

Part 4: Appendices

- The 12 Levers of Systems Change
- Definitions of ‘regenerative design’
- Creating your own artefact from the future
- Bibliography

REFERENCES

- 1.1 Intergovernmental Panel on Climate Change. *IPCC Special Report: Global Warming of 1.5°C*. Available at: www.ipcc.ch/sr15 [Accessed: December 2023].
- 1.2 Engineersdeclare.com. *UK Structural Engineers Declare Climate & Biodiversity Emergency*. Available at: www.structuralengineersdeclare.com/ [Accessed: December 2023].
- 1.3 Constructivist. *The goal of regenerative design*. Available at: <https://constructivist.co.uk/the-goal-of-regenerative-design/> [Accessed: December 2023].