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expedition
part of the Useful Simple Trust

CSIC Cambridge Centre for Smart Infrastructure & Construction

Towards Zero Loss Construction

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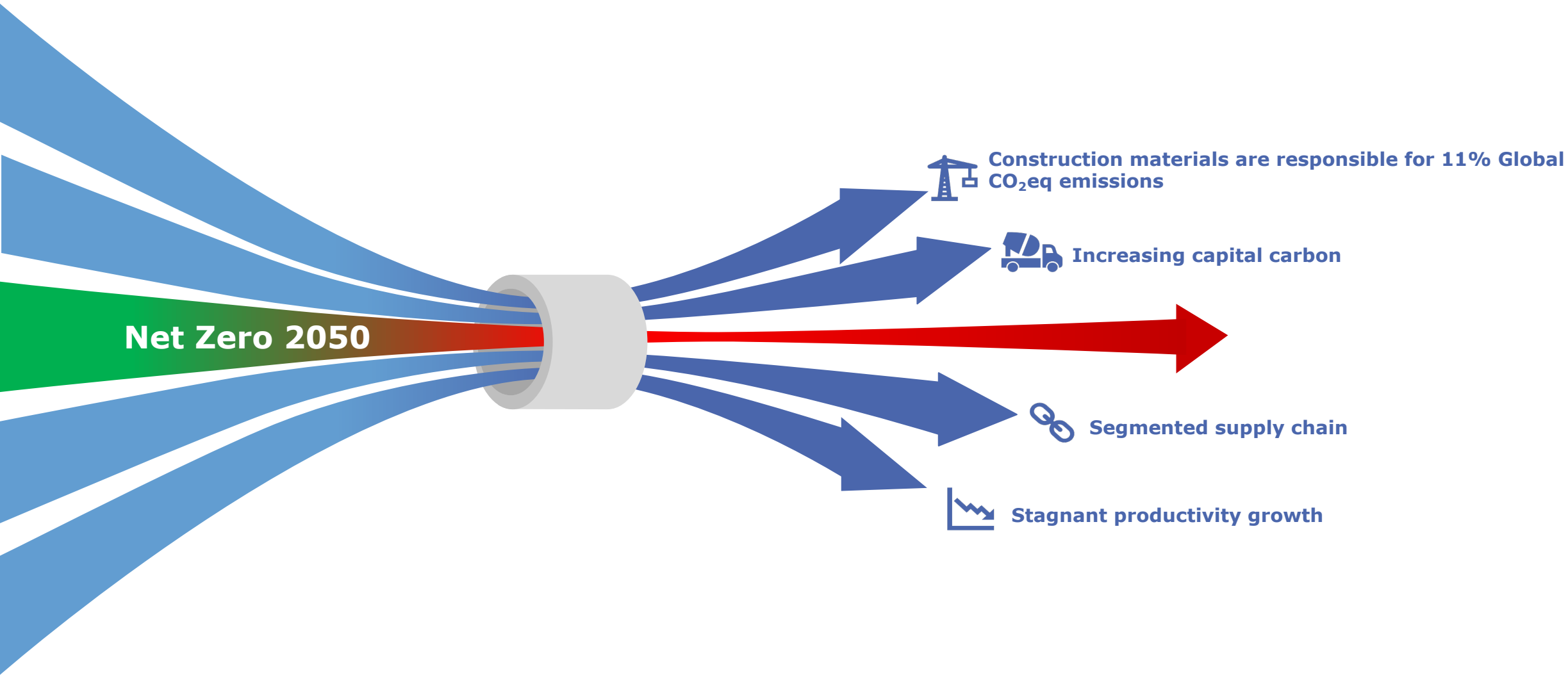
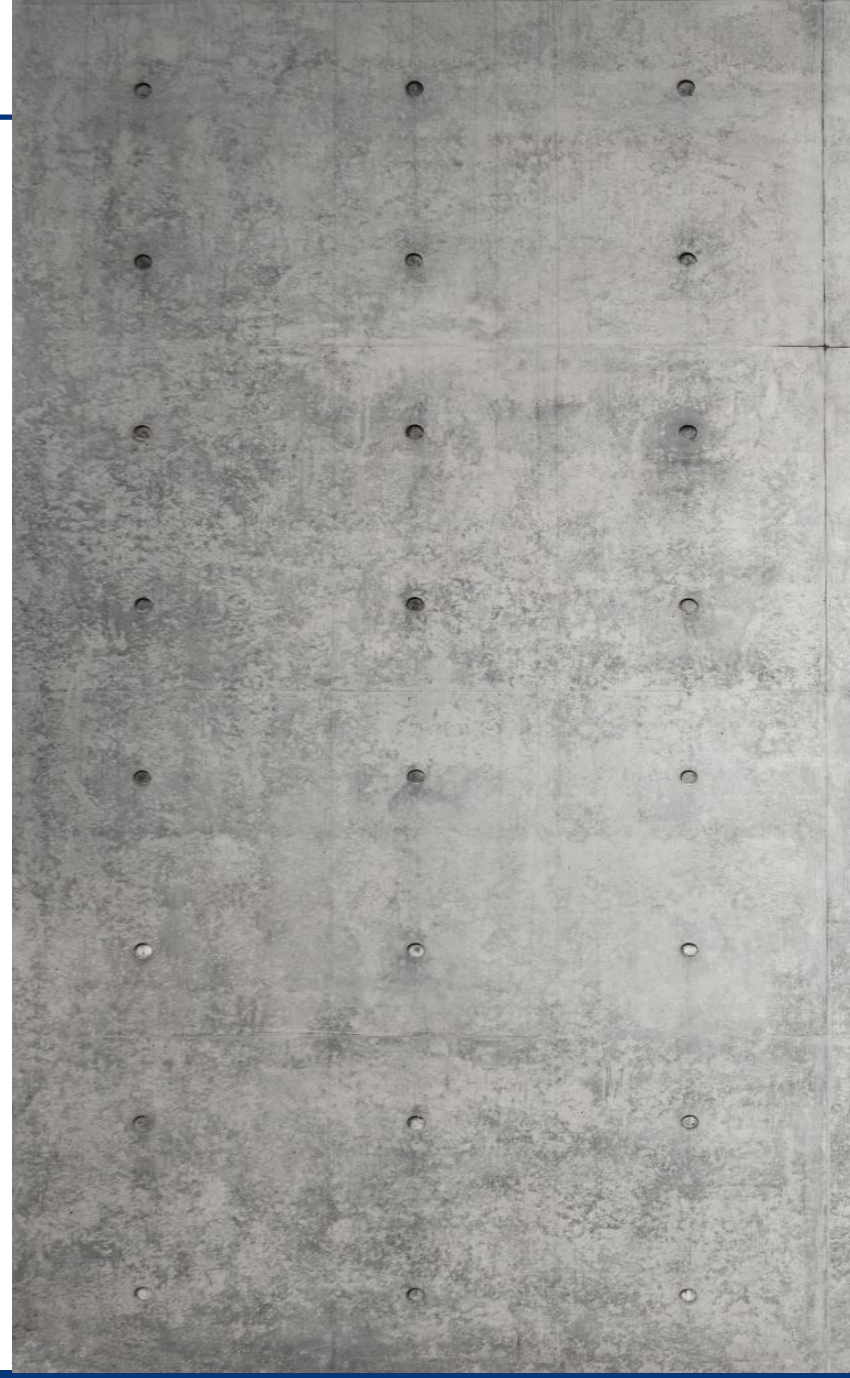
CONSTRUCTION INDUSTRY CHALLENGES



CAPITAL CARBON – CONCRETE

	Global	UK
Concrete use	4,000 Mt/y cement ~18,000 Mt/y concrete	15 Mt/y cement 82 Mt/y concrete
Carbon emissions - associated with concrete *Based on Bath ICE V3.0	3,000 $MtCO_2e$/year	14 $MtCO_2e$/year
Cost of concrete (assuming readymix to site gate)	£750 bn/year	£3 bn/year

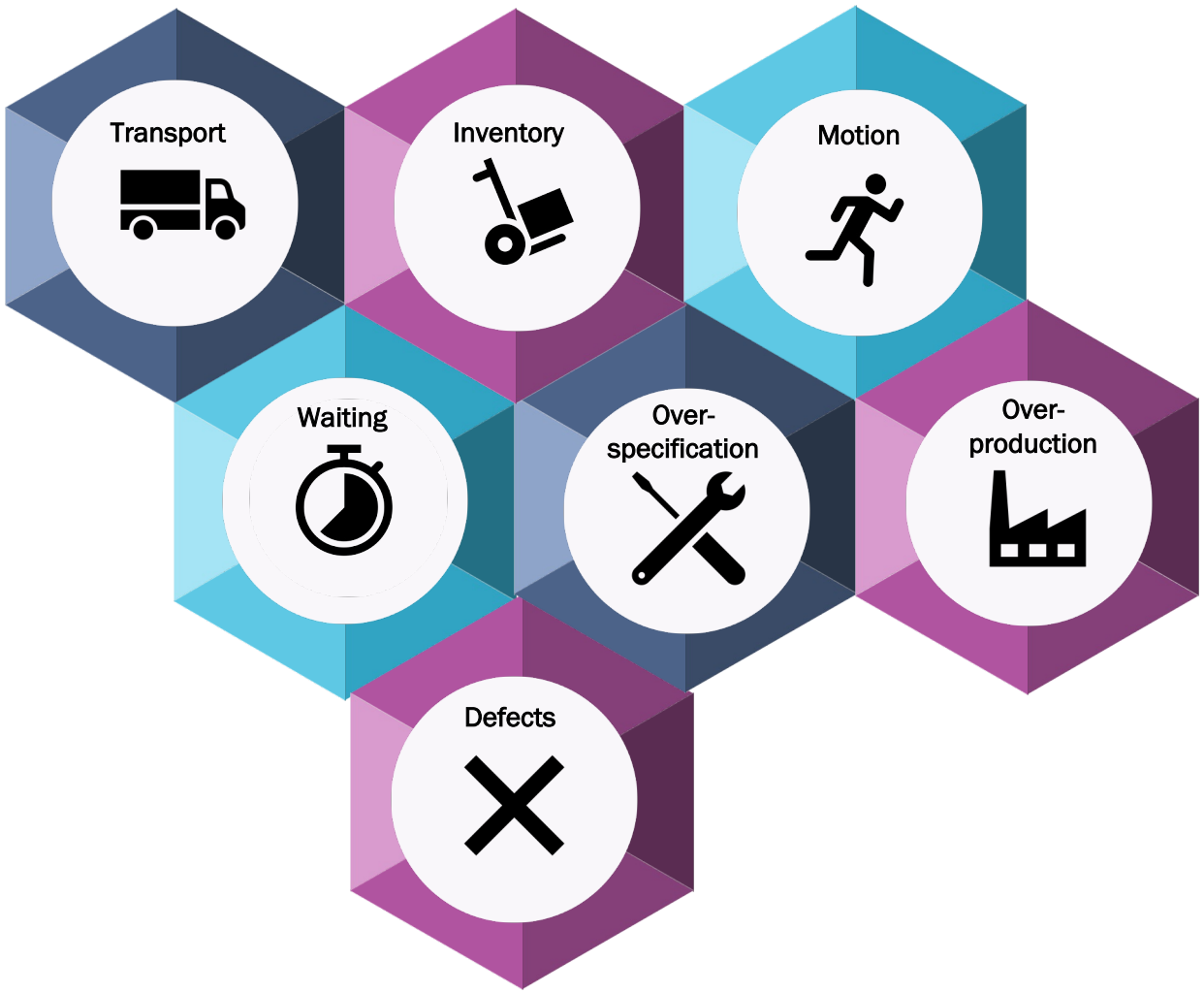
Source: Concrete Tiger Team Project -Expedition Engineering (Jan 2021)



‘Waste’ as a concept is defined in various ways in different industries and processes

- Many processes around the world **measure waste one way**: **what they put in the bin**
- Anything that is **recycled**, regardless of the **financial & environmental downgrade**, is often **excluded** from **waste figures**
- **Wasted energy** and **wasted heat** are hard to separate from unavoidable process losses

LEAN MANUFACTURING

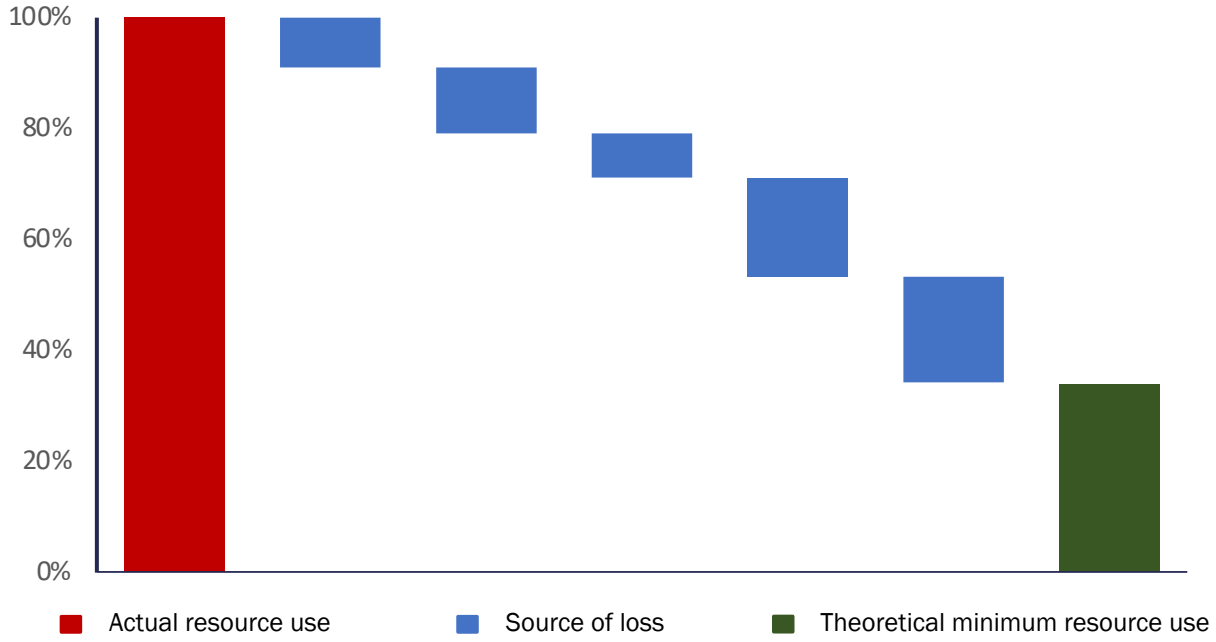


Lean manufacturing revolutionised how we look at waste, but has its **own limitations**

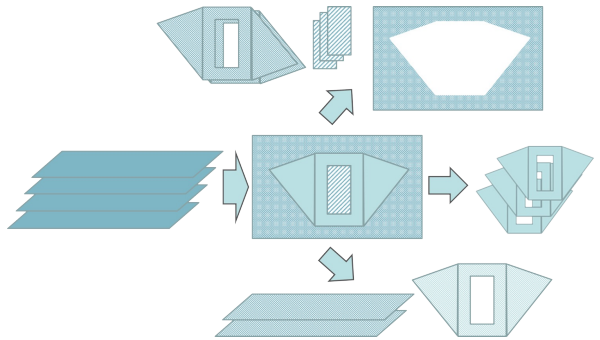
Zero loss

- **Zero Loss Manufacturing** is a **Continuous Improvement** approach from the late 1990s
- It compares **actual performance** to a first-principles theoretical **best-possible performance**
- This **removes subjectivity** or 'constraints' from the process, and **allows resource** to be focused on the **largest source** of **loss**
- Commonly used **to tackle throughput**, **cost**, and **labour productivity**

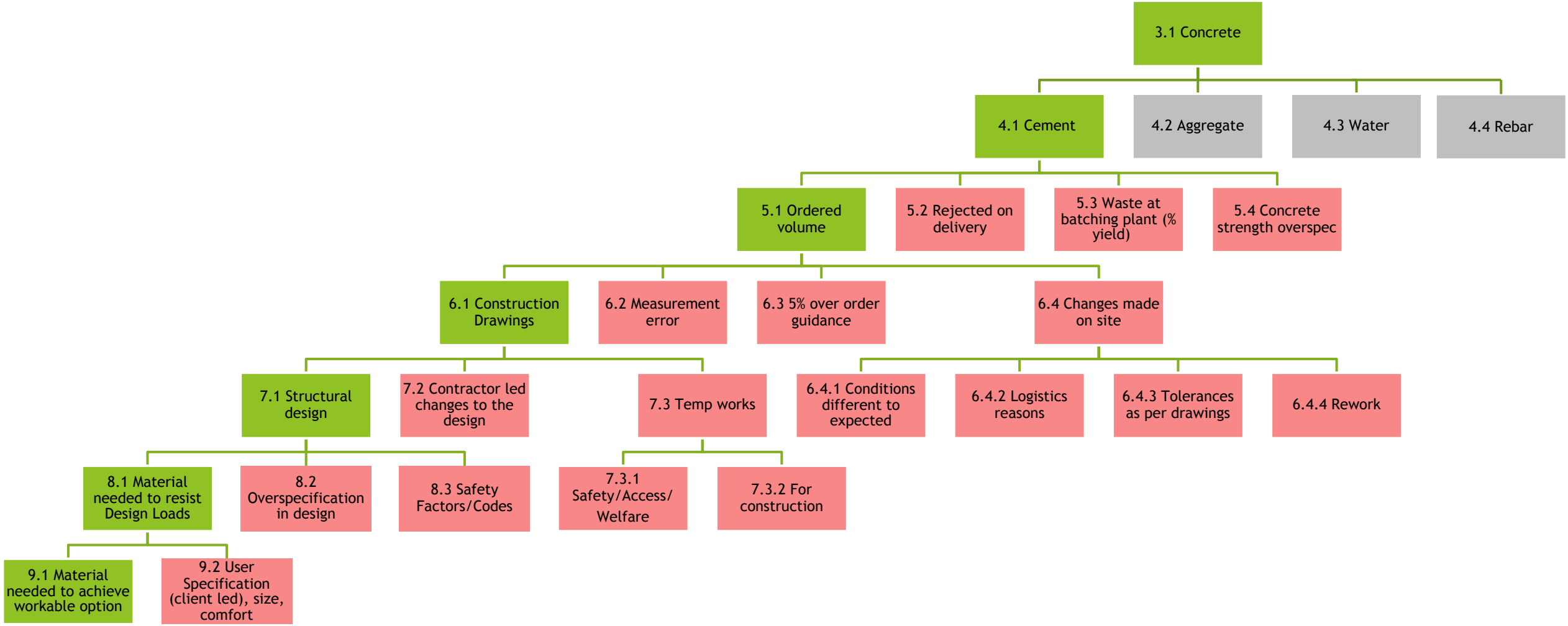
How zero loss yield analysis works (ZLYA)



- **How much material do we really need?**
- **How do we reduce the waste?**
- **Where is the excess going?**
- **What is it worth?**

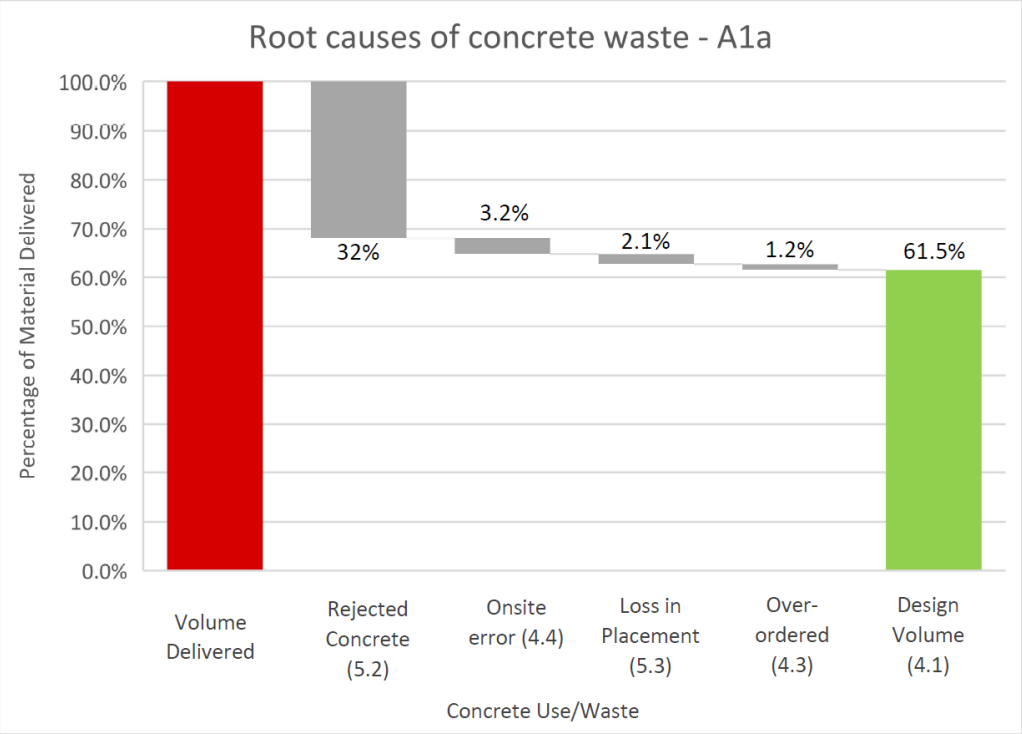


ZERO LOSS YIELD PATH – CONCRETE

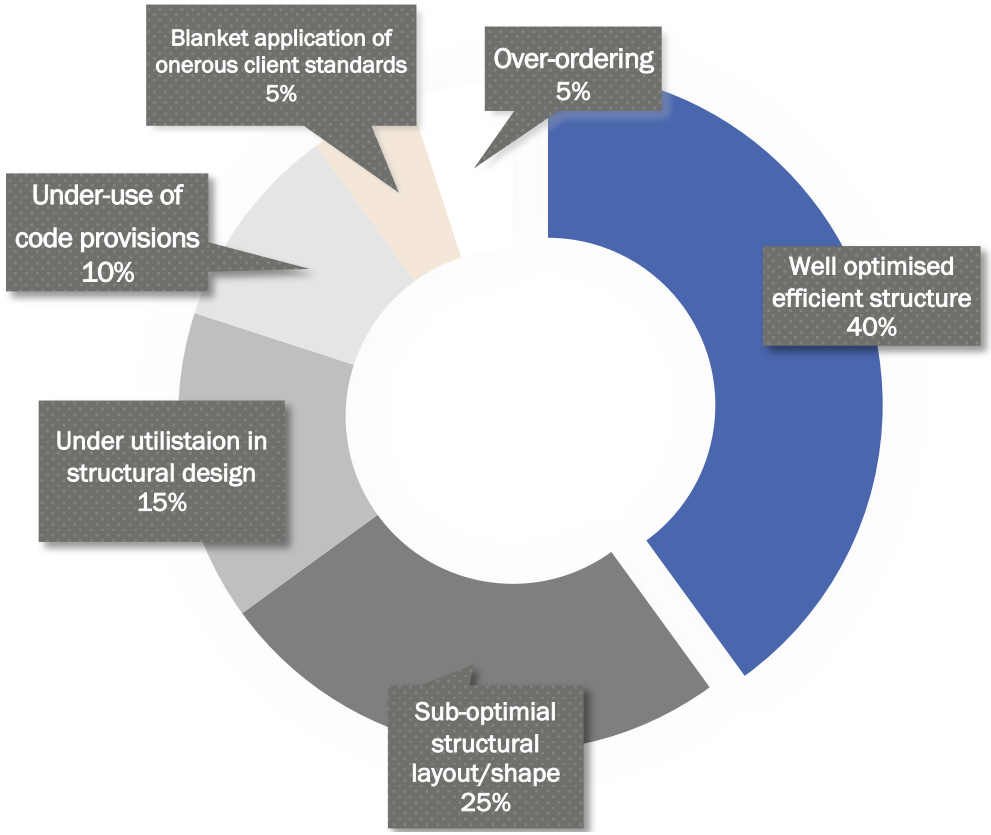


ZERO LOSS CASE STUDY – SITE A

(A) Root causes of concrete of waste on site



(B)Sub-optimal use of material in structural elements



CASE STUDY – CONCRETE PILES

- Recent project examined the **construction of concrete piles** and **reinforced beams**
- Company produces **250,000 units/year** across 133 SKUs
- **Zero Loss Cement Yield ~74%**
- Equivalent loss of **3,500t/year of CO_2**

CO_2 Goal: 10% of emissions

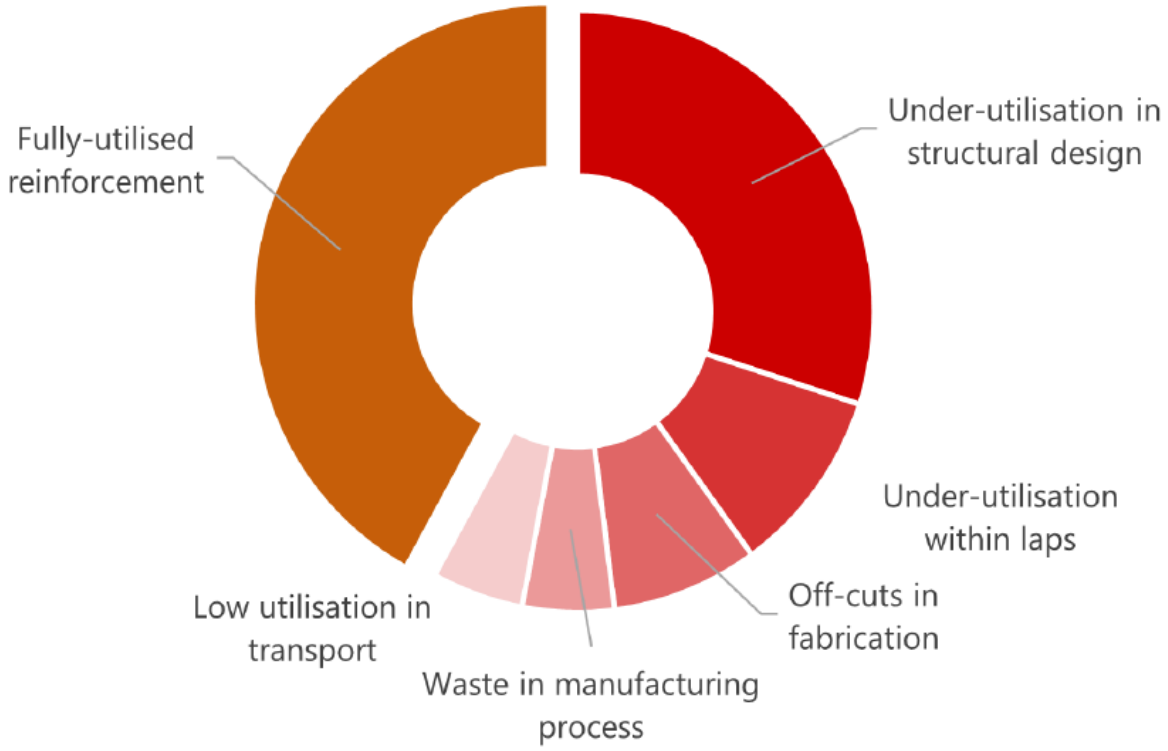
ZLYA Loss: 23% of emissions

SITE INSIGHTS

Percentage of concrete used in temporary works

Site	Ttemporary Works(% of total volume)	Project type
A1	28	Water Piling
A2	4	Water- structures
A3	6.8	Water-structures
B1	14.6	Highway-Structures
C1	13	Highway-Structures

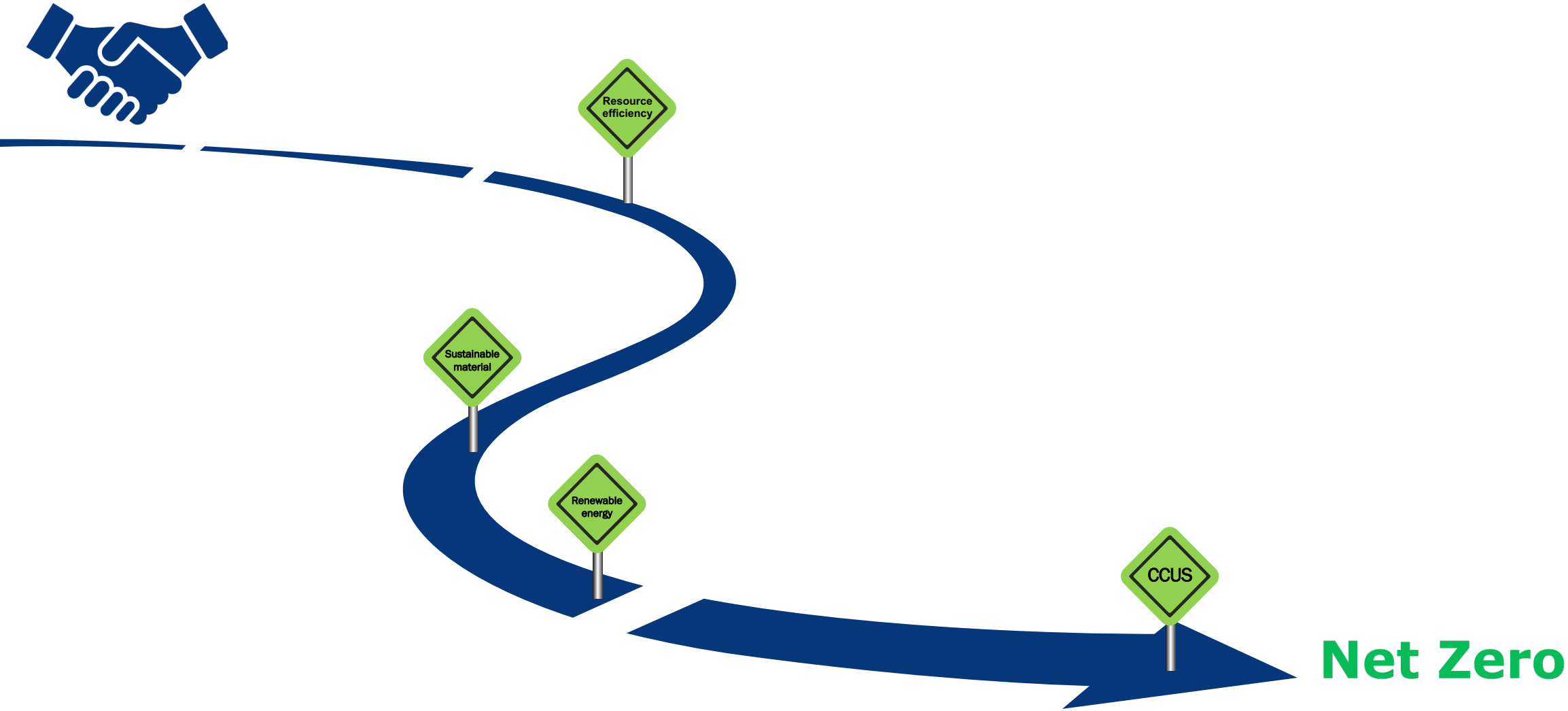
Inefficient use of reinforcement – STEEL



Notes on each of the sources of waste are included below:

- **Under-utilisation in structural design**: this is caused by many factors and difficult to quantify. One major source is the attitudes of designers; MEICON found that target utilisation for UK engineering designers is typically 75-80% and as low as 50% in real design. Refer to Section 4.5 for the various stages of design where under-utilisation is introduced.
- **Off-cuts in fabrication**: bars are generally sent from mills to fabricators in stock lengths. Depending on the size of bars required, there is likely be a wasted off-cut when bars are cut and bent for a particular project.
- **Under-utilisation within laps**: bars often need to be joined to achieve continuity of forces. This is usually achieve by lapping bars over a distance that allows the force to 'move' from one bar to the next. This distance is around 40 times the diameter of the bar and is a significant source of waste, particularly for large diameter bars.
- **Waste in manufacturing process**: this is a relatively small proportion of the total waste for reinforcement. It would be expected that a manufacturer will have optimised their processes to minimise waste.
- **Low utilisation in transport**: depending on the shapes of reinforcement transported, it is not always possible to load a lorry to capacity.
- **Fully-utilised reinforcement**: the remaining portion of the reinforcement can be considered "fully utilised", ie. working to 100% of its capacity.

TIME IS CRITICAL !!!!



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Thank you.

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