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Challenges with reuse of bridge components

NVF Climate and Environment – Webinar

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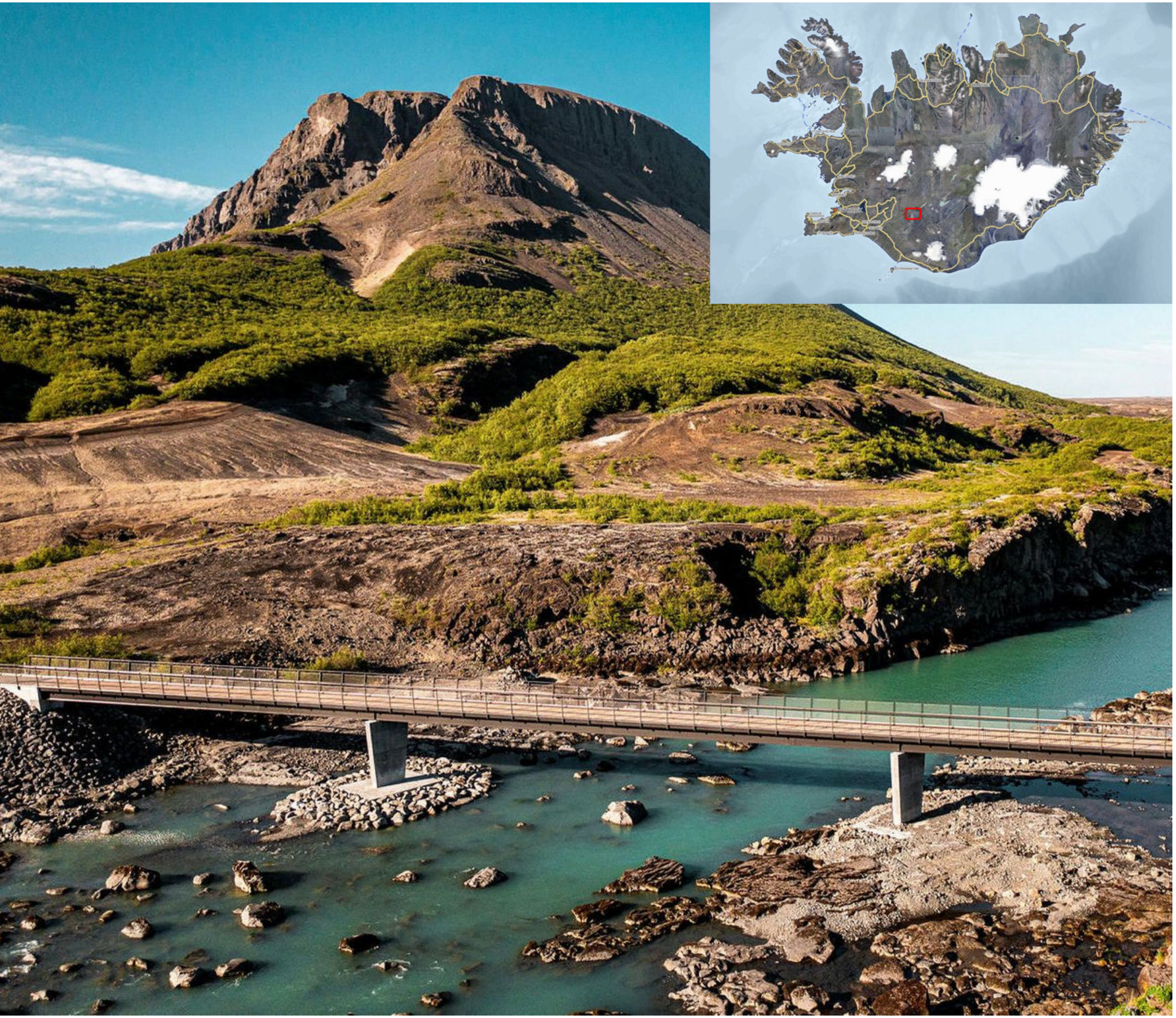
Development

- The need for reducing environmental impact when designing new bridges is a very significant design criterion
- One way of reducing the environmental impact is to reuse old bridge components when designing a new structure. Examples:
  - Reuse the substructure on site
  - Reuse a superstructure from an old bridge for a new bridge
- Reusing old bridge components is, however, not without challenges



Bridge over Þjórsá

Bridleway and hiking route

- A 102 m long and 4 m wide bridleway and hiking route bridge in 3 spans
- Bridge superstructure of steel girders with a timber deck

Bridge over Þjórsá

<u>Reuse of steel beams</u>

- In the design phase it was planned to use old steel girders that had been used in temporary bridges before
- Steelworks and surface treatment of the old girders were included in the tender
- However, this resulted in a bid with an alternative offer where it was more economical to provide new girders rather than use the old ones
- <u>Note</u> that the deck is made of Icelandic timber, the first time Icelandic timber is CE-marked and used as structural elements

Sluppenbrua

- An 80 m long road bridge in 4 spans, built in 1954
- Used as a pedestrian and cycle bridge from 2023
- Superstructure of steel girders with timber deck
- The pillars are made of dressed stone, constructed on wooden boxes, with mortar joints which originate back to 1864

Sluppenbrua - Trondheim

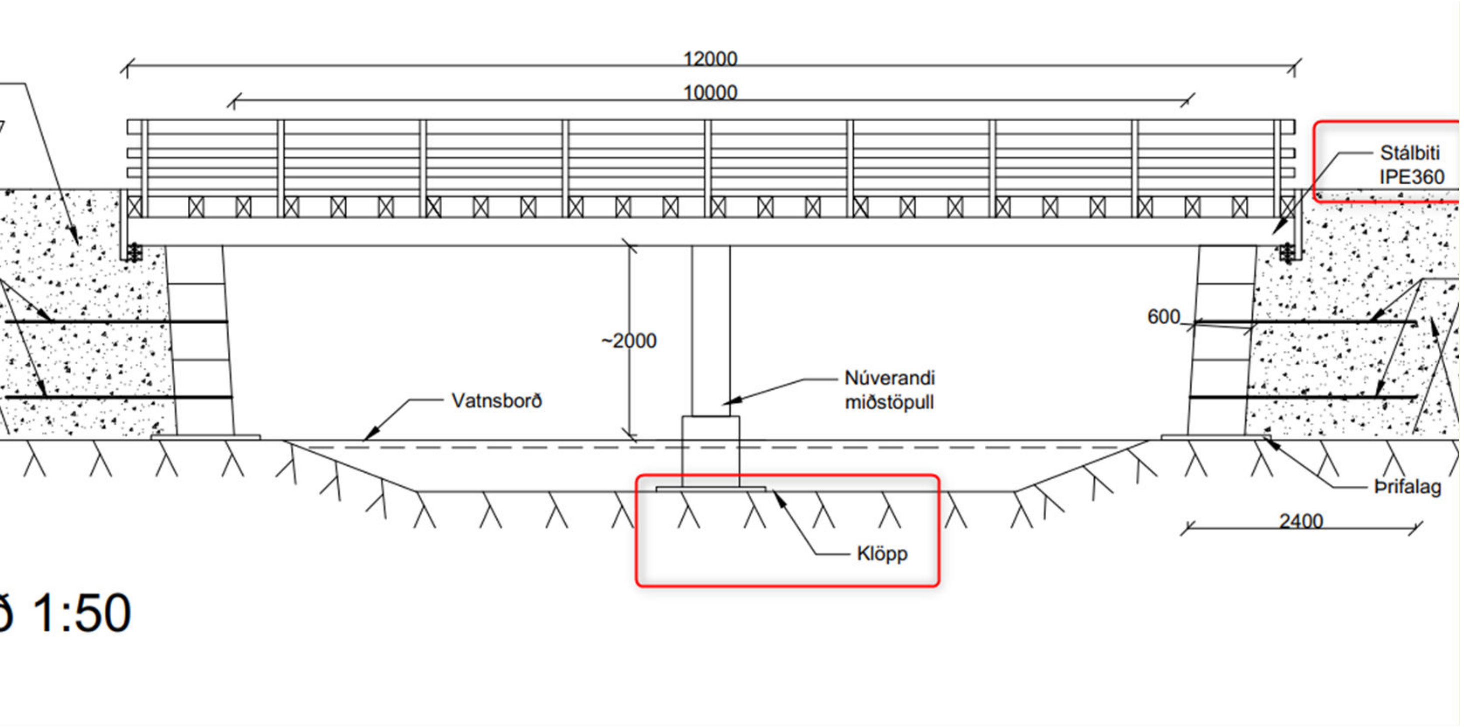
Railway bridge which opened in 1864

Sluppenbrua

- The bridge is to be refurbished as a cycle and pedestrian bridge – Ongoing project
- The superstructure needs to be renewed
  - Reuse of the steel girders
  - New deck of FRP elements
- Challenges with reuse of the old steel girders resulted in the decision to design new girders
  - Verifying the bearing capacity of the old girders with respect to corrosion and statical system
  - Cost and practical matters
- The pillars from 1864 will be used as supports for the new superstructure. Erosion protection around the pillars will be renewed

Hólmsá

- A 12 m long road bridge in 1/2 spans, built in 1922
- Single lane bridge
- Superstructure of steel girders with timber deck
- Central pillar added to the bridge later to increase capacity
- Abutments are made of a “wooden” box and stones

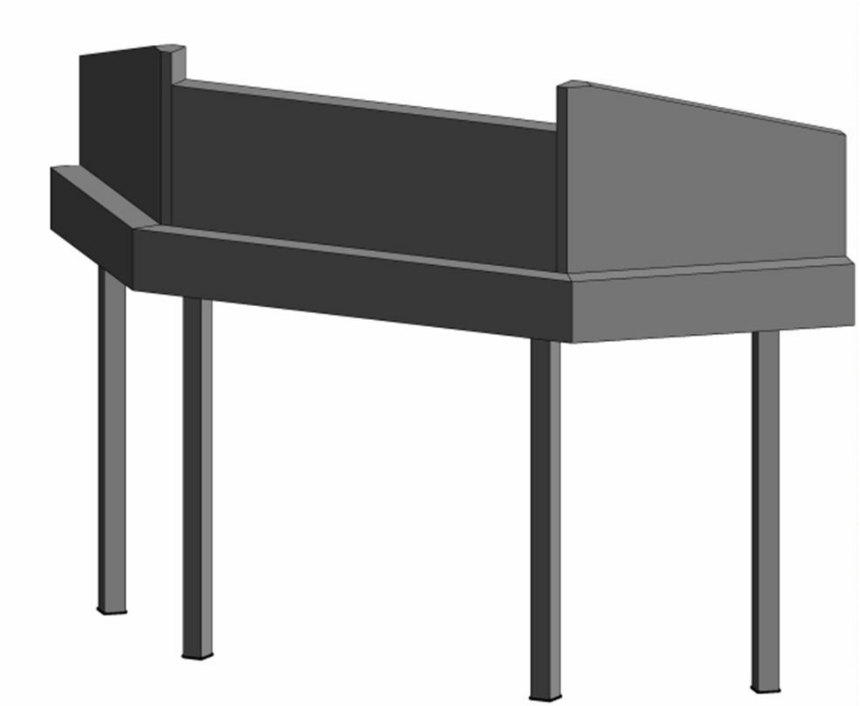


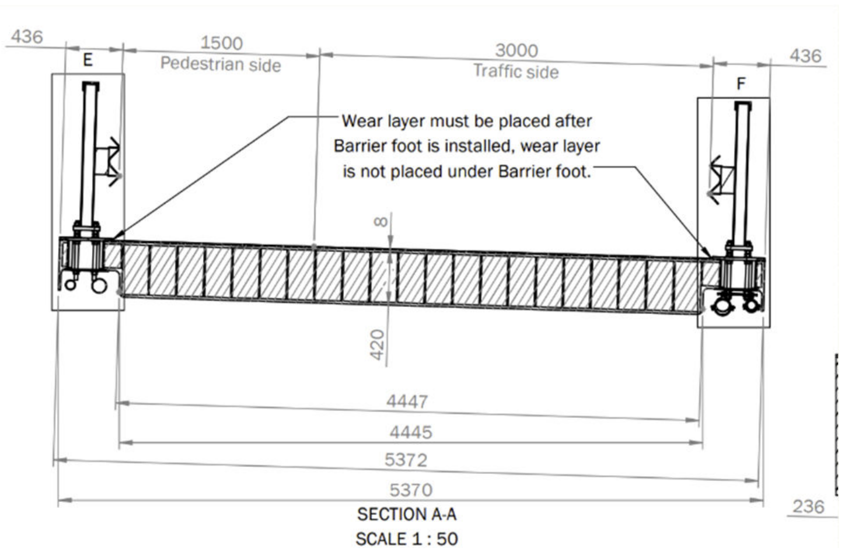
Hólmsá

- The bridge was rebuilt in 2023
- New abutments of concrete blocks
- New steel girders and timber deck
- Existing concrete pillar in the river was reused
- However, a severe flood in the river in 2024 swept the pillar away
- New steel girders were installed after the incident

Kaldá

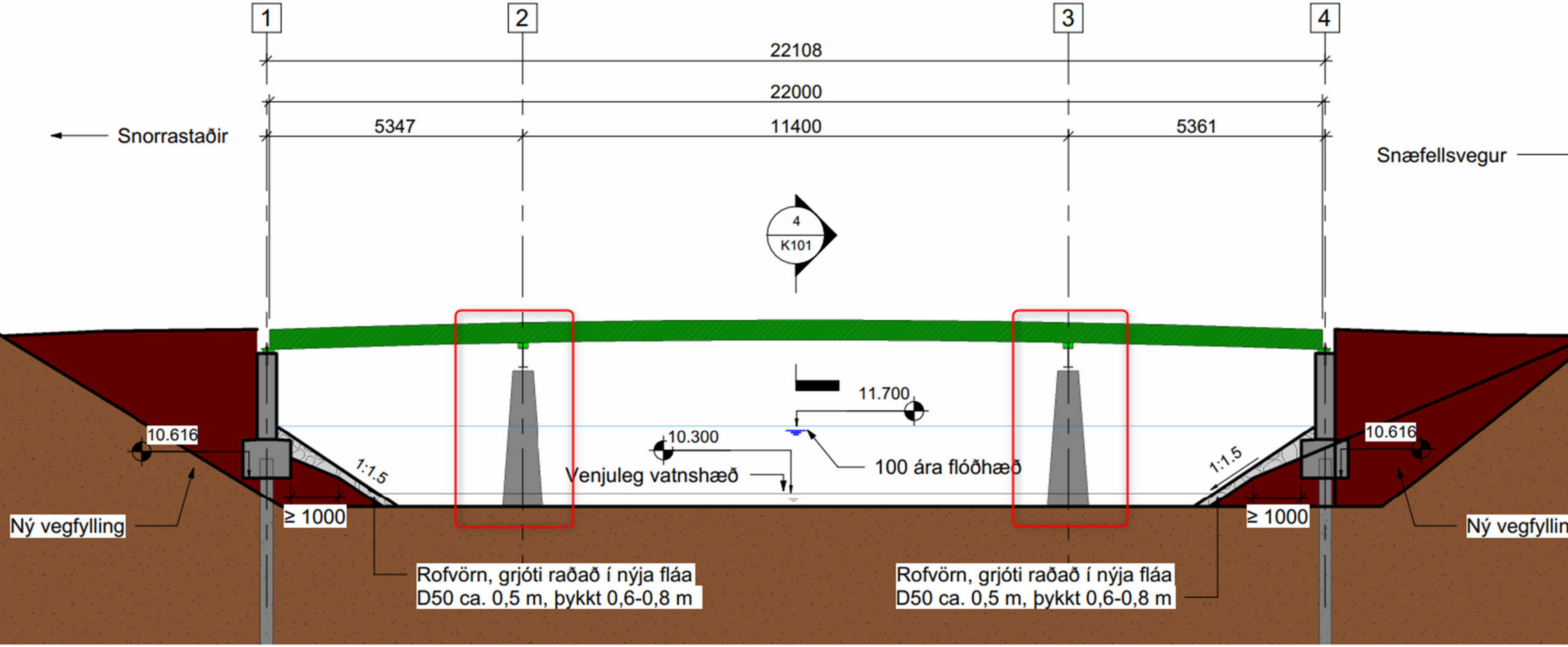
- A 33 m long road bridge in 3 spans, built in 1957
- Single lane bridge
- Superstructure of steel beams with timber deck
- Pillars of concrete on piles in the river
- Abutments are made of piles “wooden box” and stone





Kaldá

- Increase in traffic due to tourism along with deterioration of the structural system results in the need for a new bridge
- A new superstructure of FRP, one lane and pedestrian path
- The concrete pillars on the riverbed will be reused
- The abutments are rebuilt



Kaldá - New superstructure of FRP

Discussions

- Reusing old bridge components is often a feasible option
- Challenges encountered in doing this:
  - Cost
  - Design standard and rules to be used
  - The defined service life for the new bridge
  - Uncertainty

Sustainability needs maintenance

EFLA viewpoint

- Bridge components should be re-used where at all feasible:
  - „No“ environmental impact
  - Reduces waste
  - New construction materials are a finite resource
- Emphasis on extending the lifespan of infrastructure as much as possible
  - Includes better maintenance and more regular inspections
- Requirements:
  - CO_2 emissions should be appropriately costed
  - Imperfections should be endured, standards do not apply in all situations

Sustainability needs maintenance

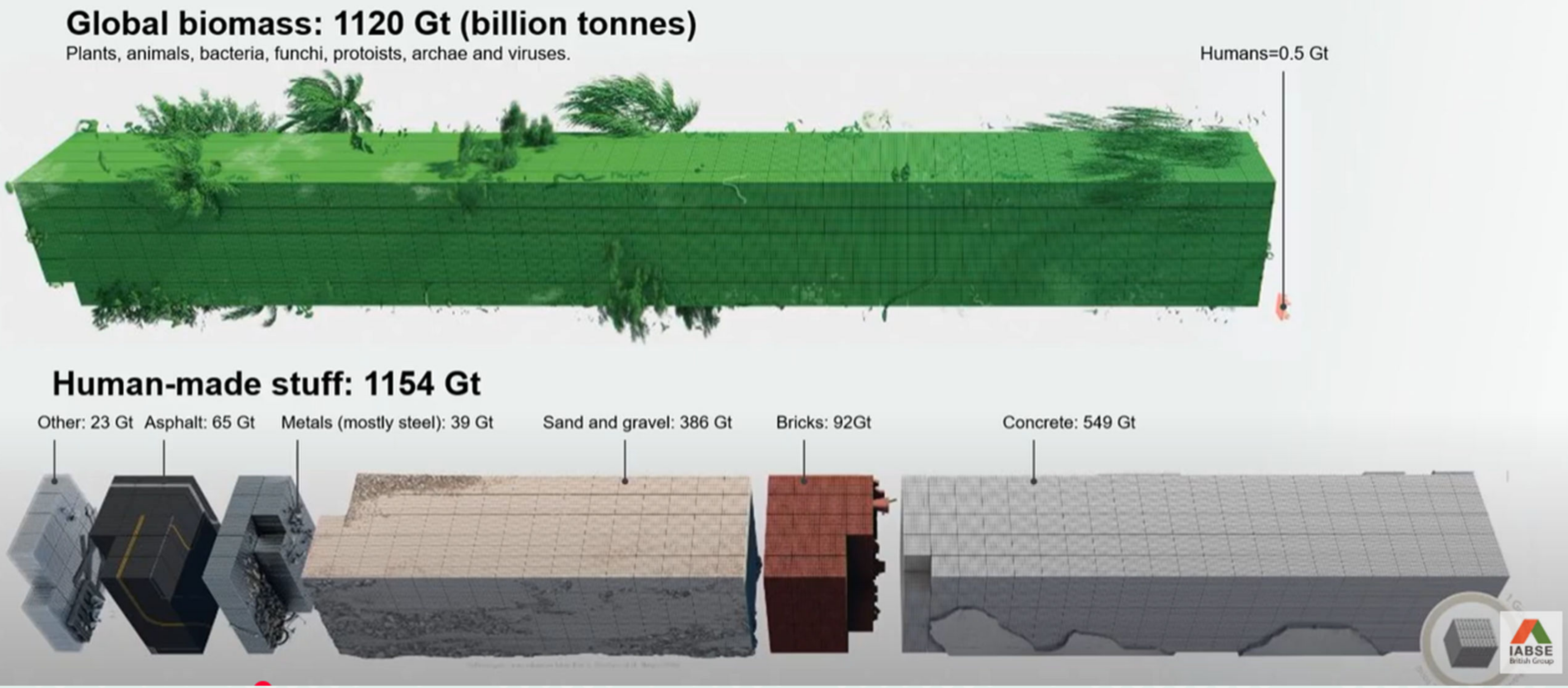
Why are we focusing on reuse and extension of lifetime for infrastructure

Because material that has been made with associated disruption of the natural environment does not have negative impact on the elements that sustainable design includes

- The short list:
  - Human health (e.g. toxicity, particulate matter)
  - Ecosystem quality (e.g. biodiversity, eutrophication, acidification)
  - Resource depletion (e.g. fossil fuels, minerals, water)

- The long list:
  1. Climate Change (Global Warming Potential) – kg CO_2-eq
  2. Ozone Depletion – kg CFC-11-eq
  3. Human Toxicity (Cancer and Non-Cancer) – CTUh
  4. Particulate Matter Formation – disease incidence per kg PM2.5
  5. Ionizing Radiation – kBq U235-eq
  6. Photochemical Ozone Formation (Smog) – kg NMVOC or kg C_2H_4-eq
  7. Acidification – mol H^+-eq or kg SO_2-eq
  8. Eutrophication (Terrestrial, Freshwater, Marine) – mol N-eq, kg P-eq, kg N-eq
  9. Ecotoxicity (Freshwater) – CTUe
  10. Land Use (Soil Quality Impact) – dimensionless (Pts)
  11. Water Use (Scarcity-weighted) – m^3 world eq. deprived
  12. Resource Use – Fossils – MJ
  13. Resource Use – Minerals and Metals – kg Sb-eq
  14. Climate Change – Fossil Sources – kg CO_2-eq
  15. Climate Change – Biogenic Sources – kg CO_2-eq
  16. Climate Change – Land Use Change – kg CO_2-eq

Consumption

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