Reducing Carbon at the Design Stage
Where are we at?

- Buildings represent 39% of global greenhouse gas emissions, including 28% in operational emissions and 11% in building materials and construction.

- In 2021 energy consumption and emissions rebounded to above 2019 values (before COVID).

- The highest growth of construction is expected into areas less reached by technology, where means of immediate reduction of embedded carbon might not be available, or too expensive (IPCC).

- All major organizations ask for urgent actions to reduce emissions of new and existing buildings.
All stakeholders involved in the building supply chain should feel responsible and committed, by thinking on “how” to influence efficiently the whole process, from the initial project conception to the execution and maintenance of its single parts, through an Integrated Design Process (IDP).
Stakeholders

GOVERNMENTS
- Certification Bodies
- Material Manufacturers

DEVELOPERS
- Universities

CONSULTANTS
- Labs
- Norms/committees

CONTRACTORS
- BIM companies
- Fabricators and Installers
How? Building Efficiently

ASSESSING THE CARBON FOOTPRINT

SUSTAINABLE LIMIT

KEEPING IT UNDER A GIVEN THRESHOLD

technology
How? Building Efficiently

IS THIS APPROACH EFFECTIVE ENOUGH?

WHAT HAPPENS IN THOSE AREAS OF NEW EXPANSION, WHERE TECHNOLOGY IS NOT AVAILABLE?
The highest influence to reduce embodied carbon is in the design stage (WGBC 2019)

Challenge: to find highly effective structural solutions, in other words...

REMOVING CAUSES!
STARS is an original project presented for the first time in DUBAI on March 25th 2022 with the support of several organizations.

STARS is showing **HOW a more efficient structural design may reduce the causes of the carbon footprint, consistently and immediately**, while increasing the durability of the construction.
The idea is simple, and it is based on replacing overlap, the most traditional way to connect reinforcing bars, with mechanical splices, which are known and used since more than 50 years.

For each overlap, an average rebar length of 50 times the rebar diameter may be replaced by a coupler, way much lighter (the smaller, the better), ensuring the continuity of the rebar.
Overlap vs. Mechanical Splices
A mechanical splice is a device to join two reinforcing bars with the capacity to transfer the full tension from one to the next.

The most popular splice is the threaded system, with two rebars threaded and connected through a coupler sleeve. 

**Mechanical splicing systems**

**With rebar preparation**

**Without rebar preparation**
SAFE SOLUTION

Loads are not depending on surrounding concrete (continuous rebars)
Traditional Overlap vs. Mechanical Splices

**Traditional Overlap**

Loads are transferred by the bonding of surrounding concrete.

*In absence of concrete, the rebar system loses its connections and fails*

**Mechanical Splices**

Loads are transferred through the splice with or without the surrounding concrete.

*In case of concrete failure the rebar behaves like a continuous one*
SAFE SOLUTION
Loads are not depending on surrounding concrete (continuous rebars)

CERTIFIED
It is a well-known and certified technology
Certification of mechanical splices

A sustainable design should guarantee safety to all projects, especially when a structural failure could end up in a major disaster with fatalities involved.

Public Structures
High rise buildings, stadiums, iconic buildings

Infrastructures
Viaducts, bridges, Metro Lines, Docks

Power Plants
NPP, Windmills, etc.
Certification of mechanical splices

A certification from an independent body ensures:

- Full traceability and marking
- Quality control
- Continuous random testing

Regular audits to the coupler manufacturing facilities and downstream facilities

A CERTIFIED mechanical splice delivers top safety to the whole project
Technical advantages

SAFE SOLUTION
Loads are not depending on surrounding concrete (continuous rebars)

CERTIFIED
It is a well-know and certified technology

AVOID CONGESTION
(better quality of finished elements)

DURABILITY
Bonding of surrounding concrete provides durability, stronger against earthquakes

DESIGN FLEXIBILITY
(smaller sections)

FORMWORKS SAVING
Constructive Advantages

- Prefabricating rebar cages
- Allow climbing formworks
- D-walls and top-down structures
- Precast concrete elements
- Less splices in longer elements
- Safety: less protruding rebars
Less Splices in Longer Elements

INCREASED EFFICIENCY FROM LESS OPERATIONS!
Until now Mechanical Splices have never been seen as a possible vehicle to reduce the steel amount in concrete elements, and what goes along with in terms of emissions, less trucks on the roads, etc...

Today we are understanding the sustainability of a safe and well-known technology that may bring a lot of benefits to the environment.
Weight Chart

Coupler vs. Overlap

Compared to LINXION Splicing couplers

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[Legend: Coupler Weight (kg) - Green, 50Ø Overlap (kg) - Red]
Case study: GRAND PARIS

320,000 Couplers delivered by BARTEC COMPANY in 2021 only for rebars dia. 16-40 mm.

Mechanical splices have been specified and used only for a few applications, and not to replace every single splice.

Compared to LINXION Splicing couplers, a total steel volume reduction of 2633 tons (-94%) is achieved.
8 Couplers trucks

108 Rebar trucks for the equivalent overlaps
Mechanical Splices are a sustainable solution compared to Overlap

Most of the biggest projects use couplers for a limited amount of applications

Technically speaking, mechanical splices are superior to the traditional overlap

Certifications guarantee the splicing performance

Mechanical splices are considered an expensive solution (is that true?)
What if ALL Overlaps were replaced by Mechanical Splices?
All overlaps replaced by mechanical splices

18 storey building
(1823 t Rebars in different sizes)

With 94,831 Mechanical splices:
-372 tons of steel
-20%

Two towers bridge
(3783 t Rebars in different sizes)

With 142,870 Mechanical splices:
-913 tons of steel
-24%
20% of 19% means...

Nearly 4% IMMEDIATE REDUCTION of the embedded carbon in each reinforced concrete building

Breakdown of embedded carbon in a finished building
Focus on UAE

Dubai was chosen for the first presentation of STARS in March 2022 for three reasons:

1) United Arab Emirates are well known for the large number of futuristic and innovative construction projects,

2) UAE is in the front line for the 2050 Net Zero emission achievement and will host COP28 this year;

3) Certified mechanical splices are used extensively in UAE, its market prices became quite low compared to European and American markets, therefore it is a better scenario for analysing the economic impact of a total replacement of overlaps.
Focus on UAE

Deira waterfront
AS MADE -1% steel
(some mechanical splices)
POTENTIAL -18% steel
(100% mechanical splices)

Bloom Towers
AS MADE -6% steel
(some mechanical splices)
POTENTIAL -18% steel
(100% mechanical splices)

Al Warqa Mall
AS MADE -4% steel
(some mechanical splices)
POTENTIAL -20% steel
(100% mechanical splices)
Cost increase for “All splices” structures

Overlap cost
- Extra Rebar Volume
- Steel rod
- Extra stirrups
- Transport Cost + Overlaps, + Rebars, + Trucks
- Formworks preparation
- Longer operations
- Longer construction
- Cost of the steel may change

Price for the end user is variable!

Mechanical splices cost
- 1 COUPLER
- 2 THREADS

Price for the end user is fixed!
Cost increase for “all splices” structures

Deira waterfront

AS MADE  -1% steel
(some mechanical splices)

POTENTIAL  -18% steel
(100% mechanical splices)

+0.5%

Bloom Towers

AS MADE  -6% steel
(some mechanical splices)

POTENTIAL  -18% steel
(100% mechanical splices)

+0.7%

Al Warqa Mall

AS MADE  -4% steel
(some mechanical splices)

POTENTIAL  -20% steel
(100% mechanical splices)

+0.4%
The cost impact of “all” mechanical splices is around 0.5% on the total cost of the building. This difference might disappear after considering volume increase and hidden costs of overlap. Even at the present conditions, we are talking about a few USD/sqm—a price low enough to disappear in the supply chain.
Should we use a solution providing...

- 4% REDUCTION OF EMBEDDED CARBON
- IMMEDIATE EFFECT
- ELIMINATE FOOTPRINT CAUSES
- MORE DURABLE BUILDINGS
- POSITIVE SIDE EFFECTS
- AVAILABLE EVERYWHERE
- ALMOST AT THE SAME COST
YES, WHAT ARE WE WAITING FOR?
Thank You

Do you have any questions?
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