“Optimizing the design process for FRP constructions”

P5 presentation - Kirolos Abdalla - 09/11/2016
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Material usage

Conventional materials used in the building sector

VS.

Materials used in other engineering sectors

Introduction
Fibre Reinforced Plastics

FRP is a composite material, consisting usually out of two materials.

- **Natural fibres**: Hemp fibres
- **Inorganic Fibres**: Glass fibres, Carbon fibres, Steel fibres
- **Metal Fibres**: Aramid fibres
- **Organic Fibres**: Hemp fibres, Glass fibres, Carbon fibres, Steel fibres, Aramid fibres

Introduction
Current applications

Bridge Oosterwolde - FiberCore

Chanel Pavilion - Zaha Hadid
**Advantages & Disadvantages**

- **Lightweight**
- **Very strong**
- **Almost no influence through weather**
- **Maintenance free**
- **Very flexible in shaping**
- **Cost more than regular building materials**
- **Prefabication is desired**
Within the current design process FRP materials are too expensive.

The cost of FRP material is more expensive than conventional building materials. Usually it is more feasible to use these materials over FRP materials.

The production process of FRP is expensive. FRP is usually shaped using moulds. These moulds are expensive to make. If a shape is very complex however, it will require more unique moulds to be created.
Objective

Creating a design and production process for FRP constructions that are economically feasible.

The design process should integrate different techniques that reduces materials from an early design stage.

The production process should reduce the amount of moulds needed.
Research question

How to optimize the design process for FRP structures by designing a self-supporting roof out of FRP-material?"

Material
1 How can material usage be reduced in roof structures?

Production process
2 How could usage of moulds be reduced in the production process of FRP?
3 What is the design method for this kind of construction?
4 What is the best production method?

Finishing
5 What is the best assembly method?

Evaluation
6 What are the strengths and weaknesses of FRP structures?
7 How could this be a general design process?
Relevance

Scientific relevance

Economical relevance

Sustainable relevance
Location
Delft Central Station

Location: Delft Central Station
Architect: Christiaan Posthumus Meyjes sr. & MECANOO

Creating a load bearing roof for the Bus station
Delft Central Station
Future situation Delft Central station

New situation is more calmer, less crossing of flows

Sight lines of the new situation
Design proposal
Double curved surfaces

Forces that act within a dome

Pantheon, Rome, Italy

Florentine dome, Florence, Italy
Shape concepts

Dome

Hyperboloid

Hypar
Shape concepts Hypar
Shape concepts Hypar
Shape dimensions
Eventual shape
Modularity
Optimizing the Design process for FRP constructions

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Connection principle
Waterproofing
ARTIC station
Waterproofing
Floorplan
Impressions
Evaluation
SWOT

- Strengths
- Weaknesses
- Opportunities
- Threats

Helpful in achieving objective
Harmful in achieving objective

Internal origins: attributes of the product
External origins: external factors
**SWOT**

**Strengths (Internal points)**
- The construction is very lightweight
- It is maintenance free
- It is hardly affected by weather influences
- Applicable to different shapes
- Pre-fabricated

**Weaknesses (Internal points)**
- Expensive material
- Expensive production process
- Elaborated design process
- Small space for margins

**Opportunities (External points)**
- New and innovative material
- Applicable to different shapes
- Fast building sequence
- Space for innovation
- Design process could help the design

**Threats (External points)**
- Need a lot of research
- Not recyclable
- No second life
- Limits in design
Conclusion