

# MEERC - WP1: Industrialization

*(More Efficient and Environmental friendly Road Construction)*

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# 1<sup>st</sup> Phd-project Ingrid Lande Larsen

PhD research fellow in Civil & Structural Engineering in the program for Technology, University of Agder (UiA).

## **Shear behavior of structural members made from locally produced Ultra High Performance Concrete (UHPC)**

Supervisors: Katalin Vertes (UiA), Rein Terje Thorstensen (UiA)

Ultra High Performance (Fiber Reinforced) Concrete (UHP(FR)C) is a relatively new material, with great potential because of high strength and durability, and potentially low environmental impact – if used wisely. The utilization has been delayed mainly because of high cost and lack of design codes.

Presently, development of design codes is emerging in several European countries. However, this is still at early stage, and only France has implemented design codes for UHP(FR)C as a national complement to EC2. It is provisionally little or no harmonization between the national initiatives.

# 1<sup>st</sup> Phd-project Ingrid Lande Larsen

Focus on making UHP(FR)C available through production from local constituents.

Two main aspects:

- Optimization of UHP(FR)C made from local constituents, with respect to environmental impact and cost.
- Investigate shear behavior of structural members made from locally produced UHP(FR)C through numerical modeling and full-scale experimental tests.

Cooperation between Nye Veier and University of Agder with focus areas *Industrialization and prefabrication* and *More environmental friendly road construction*.

## 2<sup>nd</sup> PhD-project – To be announced now

- Standardization and rationalization in bridge building:
- Initial studies on parameters as formwork solutions, reinforcement solutions, and concrete materials
- Prefabrication in element factories versus prefabrication at local temporary factories at construction sites.



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## 2<sup>nd</sup> PhD-project – To be announced now

### Durability aspects

Modern service life design approaches, requirements in codes and regulations, and structural details

Durability (long service life) is very important for sustainability



## 2<sup>nd</sup> PhD-project – To be announced now

### Sustainability aspects

The intention here is to consider the sustainability aspects through topics as new cement types (binders), alternative reinforcement materials, design for minimum maintenance cost, demolition and reuse, and **structural optimization** as background for the main part of the project.

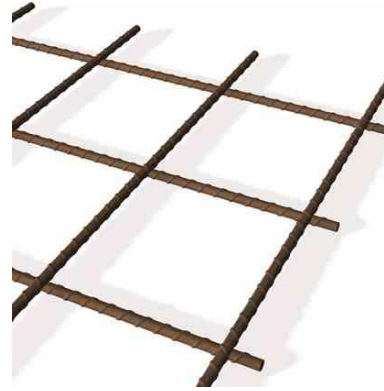


# Demonstrator – Structural analysis and design

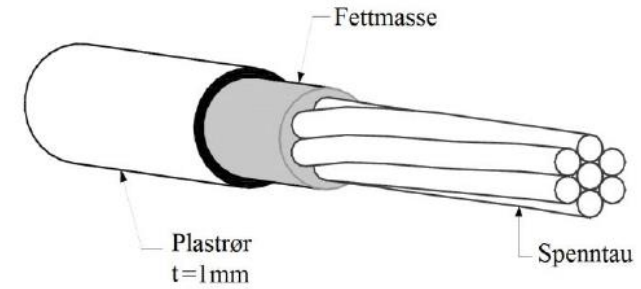
## Next generation post-tensioned structures



The bridge with serious deterioration that survived 9 Ministers of Transportation (VG, Øksnes in Vesterålen) has to be replaced



A: Traditional solution  
h=400mm, c=90mm



Figur 5: Uinjisert spennkabel (FIB, 2005)

B: Alternative solution,  
post-tensioned reinf. in p-ducts,  
h=280mm, c= 20 mm.

Estimated environmental impact of materials	CO <sub>2</sub> eq.	Amounts		CO <sub>2</sub> -eq [kg]	
		A	B	A	B
Reinforcement steel (99% recycled)	420 kg/t	1.4 t		600	
Prestressed steel	1070 kg/t		0.55 t		600
Concrete (B45MF40)	310 kg/m <sup>3</sup>	14 m <sup>3</sup>		4300	
Concrete (B35MF45 Lavkarbon A)	210 kg/m <sup>3</sup>		10 m <sup>3</sup>		2100
Sum				4900	2700

- Main part: Structural analysis and design
- Application of modern design tools (BIM and parametric design) is an important element in rationalization and standardization of engineering works, but has the disadvantage that older theoretical or experience based design tools might be cumbersome to apply.
- The need for good understanding of structural behavior and calculations and materials behavior might therefore be increasingly important.
- Furthermore might new concepts and new materials introduce special demands due to less experience based knowledge.
- Design adapted to prefabrication and standardization, modern design approaches, new concepts and materials is therefore the major topic in this PhD-project.



- Main part: Structural analysis and design
- Prefabrication of bridge elements implies coupling of concrete members with different ages, which again implies that to avoid vulnerable cracking, effects of temperature, differential shrinkage, creep, daily and seasonal temperature variations are important parameters to handle in the design.
- Furthermore can effects of temporary structural elements and systems also be decisive.
- Such effects can often be neglected in the ultimate limit states (ULS), while they in most cases have to be carefully considered in serviceability limit states (SLS) due to montage stages, prestressing operations, cracking and joint design etc.