



MAÚT30, 1-2 October 2024, Budapest Remunerative Innovations on the Field of Structural Engineering

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Balázs, GL et al.: "Innovations …", MAUT30 Budapest, 1 Oct. 2024 1/44





Aspects (A) Material and (B) Structural





3D Concrete Printing – Orthotropic behaviour



(a) The anisotropic mechanical behaviour of 3D printed slab, (b) compressive strength measurements in different directions, X direction (layer length), Y direction (layer width), and Z direction (layer height).



Compressive strength test results at 28 days Marwah M. Thajeel, György L. Balázs, 2024 (B) Structural

3D Concrete Printing –

CONCEPT:

Prefabricated segmental

bridge girder element



3D-Printed Concrete Bridge in Alcobendas, Madrid, Spain

- Year Completed: 2016
- Type:Pedestrian bridge
- Material:

Reinforced concrete





Striatus 3D-Printed Concrete Bridge Venice Biennale, Italy Designed by Zaha Hadid Architects and ETH

Year Completed: 2021 Type: Pedestrian bridge (temporary installation) Material: 3D-printed concrete blocks (without reinforcement)



- **OptiBridge Ghent University Belgium**
- Year Completed:2022Type:Pedestrian bridgeMaterial:3D-printed concrete





XtreeE 3D-Printed Bridge, France

Year Completed: In progressType: Pedestrian bridgeMaterial: 3D-printed concrete





Main benefits of using 3D printing for bridge constructions

- **1. Speed of Construction:**
- **2. Material Efficiency:**
- **3. Design Flexibility**
- **4.** Cost-Effectiveness:
- 5. Sustainability:
- **6. Reduced Need for Formwork:**
- 7. Customization:
- 9. Labor Shortage Mitigation:

Rapid Fabrication

Reduced Waste

Complex Geometries

Lower Labor Costs: Automation

Use of Recycled Materials

Simplified Construction Process

Tailored Solutions

8. Enhanced Structural Performance: Optimized Design for strength and durability

Reduced Workforce Dependence.

10. Innovative Testing and Prototyping: Rapid Prototyping: New designs can be quickly tested and iterated, facilitating innovation in bridge engineering.

3D Concrete Printing – Tensile or shear reinforcement

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3D Concrete Printing – Tensile or shear reinforcement





To improve interaction beween printed layers by a three dimensional fiber





Suspended roads





The Falkirk Wheel shipping with 18 m difference

Welcome to The Falkirk Wheel





Dept. of Construction Materials and Technologies, Concrete ResearchCONCRETEBONDREINFORCEMENT





















M4 Metro stationGellért square





Bán Lajos

Beams prestressed either with steel or with CFRP wires



Beams prestressed either with steel or with CFRP wires



BOND of FRP

Bond of reinforcement





Connections: Concrete to concrete Concrete to steel



Steel prestressing wire FRP prestressing wire



7-wire CFRP strand for bridge girders – Tokyo Rope



STRENGTHENING WITH CFRP

high strength, high durability - most elegant way of strengthening -

STRENGTHENING OF BRIDGE IN BUDAPEST

Fibre reinforced

Cementitios

Matrix

Formable reinforcement

New Reinforcement - Definition of CFCM

CFCM = Carbon Fibre Reinforced Cementitous Matrix:

- reinforcement consists of *longitudinal fibres* embedded into cement matrix using a special process
 - the matrix is cement based (not in polymer based)
- a new production and application procedure of CFCM

Patent: "Production procedure and machinery to produce cables from single fibres by embedment in a matrix and its application to concrete-composites". *PCT/HU2017/050010 int. (11 April 2016), final patent: P1700140 (dated 7 April 2017) Ferenc Csurgai*

Potential application of formable reinforcement

Inclined longitudinal reinforcement

spherical shell

Hyperbolic paraboloid shell

Helical CFCM reinforcement

Fresh reinforcement to fresh concrete

improved bond capacity:

CFCM Stirrups

Sustainable modular UHPFRC Bridge

Rotterdam, 2014 fib Awards for urstaandig sturcties - Special mentions

Possibility for Complete <u>automation and digitalization</u> of production

<u>from constituents</u> \rightarrow <u>to elements</u>

1. Production of reinforcing element STAREX

2. Mixing of concrete

3. Casting of PERFYCON elements

Force transfer by overlapping

SIFCON

SIFCON > 50% strain

Displacement [mm]

Internal confinement

THANK YOUR FOR YOUR KIND ATTENTION

CONCRETE with a new reinforcing element

Prof. György L. Balázs Budapest University of Technologies and Economics

György L. Balázs: New type of reinforced concrete

Force transfer by overlapping

György L. Balázs: New type of reinforced concrete

Effective overlapping

Beton húzott zóna
Beton nyomott zóna

György L. Balázs: New type of reinforced concrete

UHPC and SIFCON

(Orbán, Z. & Balázs L. G., 2002)

What can we do better?

- meet the present needs for possible developmets
 - + new materials and technologies
 - + sustainability, durability, service life
 - + how Artificial Inteligence (AI) influence future
- to be prepared for future challanges
- invite more practitioners
- check regularly TG activities if they proceed
- have rules for member countries which are in financial difficulties to meet fib financial

JAPAN EARTQUAKE 9.0 + TSUNAMI, 3/11 2011

Areas affected by the quake

NVKP_16-1-2016-0019

Fokozott ellenálló képességű (kémiai korróziónak ellenálló, tűzálló és fagyálló) beton termékek anyagtudományi, kísérleti fejlesztése"

Nemzeti Versenyképességi és Kiválósági Program, B alprogram: Anyagtudományi, technológiai nemzeti program

MATERIAL TESTING FORM NANO LEVEL TO MAKRO LEVEL

Concrete with air entraining agent (AEA) – increased freeze-thaw resistance

Phenom XL

DESKTOP SEM FOR LARGE SAMPLES

MATERIAL TESTING FORM NANO LEVEL TO MAKRO LEVEL

The Falkirk Wheel Shipping with 18 m difference

