UTILIZATION OF HIGH STRENGTH / HIGH PERFORMANCE CONCRETE

Proceedings

VOLUME 1

Symposium in Sandefjord, Norway
20 – 24 June 1999

Edited by

Ivar Holand Erik J. Sellevold
## CONTENTS

### VOLUME 1

<table>
<thead>
<tr>
<th>Page</th>
<th>Invited speakers:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mr. Michel Virlogeux, France: Recent Trends in Concrete Bridge Design</td>
</tr>
<tr>
<td>1</td>
<td>Mr. John A. Bickley, Canada: North-American Trends in the Development of High-Strength Concrete</td>
</tr>
<tr>
<td>14</td>
<td>Mr. Steinar Helland, Norway: Introduction of High-Strength / High Performance Concrete in the Market: A Contractor’s View</td>
</tr>
<tr>
<td>18</td>
<td>Professor, dr.techn. Ivar Holand, Norway: The Role of Research in the Development of High-Strength Concrete in Norway</td>
</tr>
<tr>
<td>25</td>
<td>Professor Dr.Ir. Joost C. Walraven, The Netherlands: The Future of High Strength / High Performance Concrete</td>
</tr>
<tr>
<td></td>
<td>Mr. Jan Moksnes, Norway: Closing remarks – Where do we go from here?</td>
</tr>
</tbody>
</table>

### 1. New Structural Concepts

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>The Evolution in the Precasting Industry</td>
<td>Alexander, S., Norway</td>
</tr>
<tr>
<td>48</td>
<td>High Strength Steel Fibre Reinforced Concrete Connections</td>
<td>Altamimi, A., Elliott, K.S., Peaston, C.H., UK</td>
</tr>
<tr>
<td>58</td>
<td>New Concepts for Prestressed Concrete Structures</td>
<td>Chekanovych, M., Ukraine</td>
</tr>
<tr>
<td>66</td>
<td>Light Weight Concrete in Norwegian Bridges</td>
<td>Fergestad, S., Norway</td>
</tr>
<tr>
<td>75</td>
<td>The Stolma Bridge - Free Cantilevering 301 meters Free Span with Pre-stressed Concrete Box Girder</td>
<td>Ingebrigtsen, T., Norway</td>
</tr>
<tr>
<td>81</td>
<td>Analysis and Design of Submerged Floating Tunnels (SFT)</td>
<td>Jakobsen, B., Østlid, H., Aadnesen, L., Norway</td>
</tr>
<tr>
<td>91</td>
<td>New Generation Marine Concrete Structures</td>
<td>Olseh, T.O., Norway</td>
</tr>
<tr>
<td>99</td>
<td>High Strength LWAC – New Opportunities in Construction and Architecture</td>
<td>Schnellenbach-Held, M., Held, M., Germany</td>
</tr>
<tr>
<td>107</td>
<td>High Strength Concrete for Protection against Penetrating Weapons</td>
<td>Smeplass, S., Markeset, G., Norway</td>
</tr>
</tbody>
</table>
2. Design Methods and Criteria, Recent and Current Research, Codes and Specifications

119 Losses by Shrinkage and Creep in HPC
   de Andrade, J.P. Jr., Pinheiro, L.M., Brazil

127 The Effect of Cover on the Strength of HSC Columns
   Attard, M.M., Foster, S.J., Australia

137 Ultimate Behaviour of Thermally-Damaged HSC Deep Beams; Test Results and Design Implications
   Beltrami, C., Felicetti, R., Gambarova, G., Italy

147 Cracking of Reinforced HSC Structures
   Bernardi, S., Mesureur, B., Rivillon, Ph., France

154 Flexural Behaviour of Prestressed Fiber Reinforced Concrete Bridge Beams
   Biolzi, L., Cattaneo, S., Guerrini, G., Italy

164 Evaluation of The Flexural Strength of HPC Beams
   Borges, J.U.A., Bittencourt, T., Brazil

174 Strength of Lapped Splices in Reinforced HSC Columns
   Burkhardt, J., Hegger, J., Germany

184 Slender Concrete Columns Subjected to Sustained and Short-Term Eccentric Loading
   Claeson, C., Sweden

194 Finite Element Analysis of Confined HSC Columns
   Claeson, C., Johansson, M., Sweden

203 Structural Properties of High Performance Lightweight Concrete
   Curcio, F., Galeota, D., Gallo, A., Giammatteo, M.M, Italy

213 Experimental Study of HSC Beams under Cyclic and Alternating Loading
   Daniel, L., Loukili, A., Le Touzo, J.Y., Lamirault, J., France

222 Long-Term Strength and Reliability of HSC Columns under Sustained Loads
   Diniz, S.M.C, Brazil

232 Design of HPC Structures - A Swedish Handbook
   Elfgren, L., Bernander, S., Emborg, M., Garielsson, H., Groth, P., Hedlund, H.,

243 Experimental Analysis of Influence of Flexure-Shear Interaction on the Rotation Capacity of HPC Beams
   Fabbrocino, G., Pecce, M., Italy

253 Thickness of Shear Flow Zone in HSC Members Subjected to Pure Torsion
   Fang, I-K., Lai, Y-G, Shiau, J-K., Taiwan

262 The Strength and Ductility of HSC Beams with Minimum Torsional Reinforcement
   Fang, I-K., Shiau, J-K., Young, W.T., Taiwan

272 Hanger Reinforcement in HSC Beams with Web Opening in the Shear Span
   Fernandes, G.B., Brazil

282 The Fallacy of Early Cover Spalling in HSC Columns
   Foster, S.J., Australia

292 Ultimate Strength of Slender Walls in Concrete Box Girder Bridges
   Giaever, N.A., Jakobsen, B., Norway
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>302</td>
<td>Behaviour of HSC under Bending Compression</td>
<td>Gonzalez, D., Vicente, M.A.</td>
<td>Spain</td>
</tr>
<tr>
<td>312</td>
<td>Shear Capacity of Prestressed Concrete Beams of HSC Elements</td>
<td>Görtz, S., Hegger, J.</td>
<td>Germany</td>
</tr>
<tr>
<td>322</td>
<td>HSC Beams Subjected to Shock Waves</td>
<td>Hallgren, M., Balazs, P.</td>
<td>Sweden</td>
</tr>
<tr>
<td>332</td>
<td>Analytical Study of Influence of Concrete Strength on Column Design</td>
<td>Harit, A.K., Gupta, S.S.</td>
<td>India</td>
</tr>
<tr>
<td>342</td>
<td>The Strength and Ductility of Steel Fibre-Reinforced HSC</td>
<td>Hassanzadeh, M.</td>
<td>Sweden</td>
</tr>
<tr>
<td>354</td>
<td>Analysis of HSC Deep Beams Using a New Finite Element Model for Concrete</td>
<td>He, X.G., Kwan, A.K.H., Chan, H.C.</td>
<td>Hong Kong</td>
</tr>
<tr>
<td>362</td>
<td>HSC in Model Code 90</td>
<td>Holand, I.</td>
<td>Norway</td>
</tr>
<tr>
<td>368</td>
<td>Safety and Reliability of Concrete Structures. HPC Exposed to Extreme Loading</td>
<td>Jensen, J.J.</td>
<td>Norway</td>
</tr>
<tr>
<td>378</td>
<td>Creep and Shrinkage in HPC – An Engineering Approach</td>
<td>Jonasson, J-E., Westman, G., Hedlund, H.</td>
<td>Sweden</td>
</tr>
<tr>
<td>388</td>
<td>Early Age Concrete Field Tests at the Maridals Culvert. Part Two: Model Parameter Identification and Numerical Simulation.</td>
<td>Kanstad, T., Bosnjak, D., Bjøntegaard, Ø., Sellevold, E., Petkovic, G., Heimdal, E.</td>
<td>Norway</td>
</tr>
<tr>
<td>411</td>
<td>Analytical Model for Confined Concrete Columns</td>
<td>Légeron, F., France, Paultre, P.</td>
<td>Canada</td>
</tr>
<tr>
<td>421</td>
<td>ISO Standard for Fixed Concrete Structures</td>
<td>Leivestad, S.</td>
<td>Norway</td>
</tr>
<tr>
<td>427</td>
<td>Mechanical and Fracture Mechanical Behaviour of HSC</td>
<td>Lolland, K.E.</td>
<td>Norway</td>
</tr>
<tr>
<td>436</td>
<td>Shear of High Strength Prestressed Concrete Stemmed Members</td>
<td>Ma., Z.J., Tadros, M.K., Baishya, M.</td>
<td>USA</td>
</tr>
<tr>
<td>448</td>
<td>Influence of Stiffness Changes and Joint Deformability on Redistribution of Internal Forces in Multistorey Framed Structures</td>
<td>Malesza, M., Malesza, J., Miedzialowski, C.,</td>
<td>Poland</td>
</tr>
<tr>
<td>455</td>
<td>Continuous Description Changes of the Section Stiffness of R.C. Walls in Multistorey Buildings</td>
<td>Miedzialowski, C., Malesza, J., Malesza, M.,</td>
<td>Poland</td>
</tr>
<tr>
<td>461</td>
<td>Investigation of Destruction Zone Resistance of HSC of Beams Under Shear Forces Action</td>
<td>Mitrofanov, V.P.</td>
<td>Ukraine</td>
</tr>
<tr>
<td>469</td>
<td>Shear Design of HSC Beams Subject to Axial Compressive Stress</td>
<td>Moreno, A.L., Marinho, A.</td>
<td>Brazil</td>
</tr>
</tbody>
</table>
478 Shear Strength of Steel Fibers Reinforced HSC Beams
Moreno, A.L., de Oliveira Pinto Jr., N., Brazil

487 Composite Columns of Concrete-Filled Hollow Section: Experimental Evaluation of the Axial Capacity
De Nardin, S., de C. El Debs, A.L.H., Brazil

497 Prestressed HSC Members – Anchorage Zone and Crack Control
Nitsch, A., Hegger J., Germany

507 Inclined Stirrup as Shear Reinforcement in HPC Flat Slabs
Oliveira, D.R.C., Melo, G.S., Brazil

517 Residual Bond Strength of Steel Embedded in HSC after Exposure to High Temperatures
Papayianni, I., Ktsidis, A., Tsivdaris, I., Greece

526 Use of High-Yield Strength Steel to Confine HSC Columns Subjected to Seismic-Type Loading
Paultre, P., Mongeau, D., Canada, Légeron, F., France

536 Experimental Study on HSC Corbels
Pinheiro, L.M., Torres, F.M., Brazil

546 HSC Thin-Web Roof-Elements: An Experimental Investigation on Steel Fibre Benefits
di Prisco, M. di, Felicetii, R., Italy

556 Experimental Analysis of HSC Columns (60MPa) Under Axial Compression
de Queiroga, M.V.M., Giongo, J.S., Takeya, T., Brazil

566 Experimental and Analytical Work on Confined HSC
Ramdane, K-E., Watanabe, F., Nishiyama, M., Japan, Assa, B., Indonesia

578 Effect of Reinforcement Ratios on Flexural Behavior of HSC Beams
Rashid, M. A., Mansur, M. A., Paramasivam, P., Singapore

588 Strength and Brittleness of HPC Slabs
Rosati, G.P., Meda, A., Guerrini, G.L., Italy

598 Deformation and Crack Width of Prestressed Reinforced HSC Members
Sato, R., Tezuka, M., Anzai, S., Japan

608 Bearing Behaviour of HSC Walls
Seelmann, F.M.K., Germany

618 Design Models Proposed for HSC Column Design
Stewart, M. G., Attard, M.M., Australia

628 Ultimate Capacity Design of Confined HSC Columns
Sun, Y., Sakino, K., Japan

636 Mechanical Properties of Ultra HSC Confined by Steel Tube
Sun, Y., Ikenono, Y., Sakino, K., Japan

646 Strength and Ductility of Reinforced Concrete Columns Strengthened with HPC Jackets
Takeuti, A.R., de Hanai, J.B., Brazil

656 High Strength/HPC in Norwegian Code NS3473 – 1998
Thorenfeldt, E., Norway

667 Modified Properties and Structural Behaviour of HSC
Tomaszewicz, A., Norway

673 Theoretical-Experimental Analysis of Reinforced HSC Columns Under Eccentric Compression
Vanderlei, R.D., Giongo, J.S., Takeya, T., Brazil
VOLUME 2

3. Construction - Case Records, New Techniques and Applications

729 An Investigation for Determining Optimal HPC FRC for Replacement of Reinforcement Bars in Post-tensioned Bridges
Ay, L., Sweden

738 Punching Shear Resistance and Ductility on High Strength and Steel Fiber Reinforced Concrete Flat Slabs
de Azevedo, A. P., de Hanai, J.B., Brazil

748 Utilisation of HS/HPC in Repair/Rehabilitation of Structures
Bhattacharjee, J., India

758 High Performance Self Compacting Concrete. Norwegian Experiences
Erlien, O., Heimdal, E., Norway

770 HPC for Pavement Applications
Goodspeed, C.H., Thibodeau, V., Denton, L., Vanikar S.N., USA

781 Area of an Effective Utilisation of HSC in Precast Frame Buildings and Engineering Structures
Granev, V.V., Kodysh, E.N, Trekin, N.N., Russia

786 Early Age Concrete Field-Tests at the Maridal Culvert. Part one: Project Description and Test Results
Heimdal, E., Helland, S., Kanstad, T., Kompen, R., Petkovic, G., Norway

798 Removal and Recycling of High Strength Offshore Concrete Structures
Hoyland, K., Masliah, J., Norway

809 Construction and Design of High-Rise Buildings Using 100 MPa HSC
Jinnai, H., Namiki, S., Kuroha, K., Kawabata, I., Hara, T., Japan

819 An ALWAC Footbridge over the Gera near Rudisleben (Thuringia) – First Application of HSC Bars
König, G., Faust, T., Novák, B., Germany

830 Modelling HPC with Increased Ductility
König, G., Klützing, L., Germany