# Composite Construction in Steel and Concrete V

## Table of Contents

Hybrid Girders—Strength and Fatigue Design Rules Based on Experimental and Numerical Studies

- Daniel Bitar, Heiko Trumpf, Yvan Galea, and Mladen Lukić (Page 1)

The New German Design Code for Composite Bridges

- Gerhard Hanswille (Page 13)

Measurements during Construction and Launching of a 130 m Span Length Composite Bridge

- Jean-Paul Lebet (Page 25)

Partial-Interaction Behavior of Steel-Concrete Composite Bridge Deck


Numerical Investigation of Moment Redistribution in Continuous Beams of Composite Bridges

- Samy Guezouli and Jean-Marie Aribert (Page 47)

Inelastic Behavior of a Continuous Composite Box-Girder Bridge with Prefabricated Slabs

- Chang-Su Shim, Hyung-Keun Ryu, Chul-Hun Chung, Seok-Goo Youn, and Sung-Pil Chang (Page 57)

Shear Resistance of Concrete Bridge Decks in Tension

- Jochen Ehmann and Ulrike Kuhlmann (Page 67)

Influence of Concrete Cracking on Composite Bridge Behavior

- Jean-Paul Lebet and Miguel Gómez Navarro (Page 77)

Short Span Modular Composite Bridges

- Uwe E. Dorka and Jörg Pruss (Page 87)

Partial-Interaction Fatigue Assessment of Continuous Composite Steel-Concrete Bridge Beams

- Rudolf Seracino (Page 93)

Composite Design for Small and Medium Spans

- Gerhard Sedlacek and Heiko Trumpf (Page 105)
### Innovative Composite Systems

**A True Innovation: Steel Plates with a Structural Elastomer Core** ........................................ 114  
S. J. Kennedy, D. J. L. Kennedy, R. A. Dorton, D. G. Wright,  
and R. B. Vincent

**Experimental Study on Strength and Stiffness of Bare Type CFT Column Base with Central Reinforcing Bars** ........................................................................................................ 127  
Haruyoshi Kadoya, Jun Kawaguchi, and Shosuke Morino

**Sandwich Panels with Openings** .......................................................................................... 137  
Marc Böttcher and Jörg Lange

**Short- and Long-Term Tests of the Strengthening of Concrete Floor Panels with External Bonded Reinforcement** ......................................................................................... 147  
Petr Stepanek, Ivana Svarickova, Jan Fojtl, Vladimir Dibelka,  
and Tomas Vanura

### Composite Slabs

**Models for the Longitudinal Shear Resistance of Composite Slabs and the Use of Non-Standard Test Data** ................................................................. 157  
Roger P. Johnson

**New Method for the Design of Composite Slabs** ............................................................... 166  
Michel Crisinel and Philippe Edder

**Load-Deformation- and Vibration-Behaviour of New Types of Composite Slim-Floor Slabs** .................................................................................................................. 178  
Christiane Butz, Oliver Hechler, Heiko Trumpf, and Markus Feldmann

**Design Considerations for Composite Beams Using Precast Concrete Slabs** .......... 190  
Stephen Hicks, R. Mark Lawson, and Dennis Lam

**Finnish Code Provisions for the Design of Hollow Core Slabs Supported on Beams** ... 202  
Matti V. Leskelä

**Shear-Bearing Capacity of the Concrete Slab at Web Openings in Composite Beams** ................................................................. 214  
Wieland Ramm and Christian Kohlmeyer

**Composite Shear Head Systems for Improved Punching Shear Resistance of Flat Slabs** ................................................................................................. 226  
Wolfgang Piel and Gerhard Hanswille
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcement Requirements for Secondary Composite Beams Incorporating Trapezoidal Decking</td>
<td>236</td>
</tr>
<tr>
<td>Stefan Ernst, Mark Patrick, Russell Bridge, and Andrew Wheeler</td>
<td></td>
</tr>
<tr>
<td>Vibration Characteristics of Modern Composite Floor Systems</td>
<td>247</td>
</tr>
<tr>
<td>Stephen Hicks and Paul Devine</td>
<td></td>
</tr>
<tr>
<td>Design of Edge Beams in Slim Floors Using Precast Hollow Core Slabs</td>
<td>260</td>
</tr>
<tr>
<td>Jörg Lange</td>
<td></td>
</tr>
<tr>
<td>Investigations on Beams with Multiple Regular Web Openings</td>
<td>270</td>
</tr>
<tr>
<td>Oliver Hechler, Christian Müller, and Gerhard Sedlacek</td>
<td></td>
</tr>
<tr>
<td>The Behaviour and Design of Haunches in Composite Beams and their Reinforcement</td>
<td>282</td>
</tr>
<tr>
<td>Russell Bridge, Stefan Ernst, Mark Patrick, and Andrew Wheeler</td>
<td></td>
</tr>
<tr>
<td>Accounting for the Effects of Non-Ductile Shear Connections in Composite Beams</td>
<td>293</td>
</tr>
<tr>
<td>Matti V. Leskelä</td>
<td></td>
</tr>
<tr>
<td>Deflection of Steel Concrete Composite Beams in Real Structures as Basis for the Calculation of the Serviceability of Buildings</td>
<td>304</td>
</tr>
<tr>
<td>Hauke Grages and Jörg Lange</td>
<td></td>
</tr>
<tr>
<td>Deflection Behaviour of Composite Girders with Reduced Height</td>
<td>314</td>
</tr>
<tr>
<td>Ulrike Kuhlmann and Andreas Rieg</td>
<td></td>
</tr>
<tr>
<td>Development of a New Type of Composite Underspanned Beam</td>
<td>325</td>
</tr>
<tr>
<td>Michel Crisinel, François Sautier, Gabriele Guscetti, Friedrich Kalix, Nicolas Perregaux, and Marc Walgenwitz</td>
<td></td>
</tr>
<tr>
<td>The Effects of Partial Shear Connection in Hogging Moment Regions of Composite Beams and Joints</td>
<td>336</td>
</tr>
<tr>
<td>Brian Uy, Hing Yip Loh, and Mark Bradford</td>
<td></td>
</tr>
<tr>
<td>Structural Behaviour of Partially Concrete Encased Composite Sections with High Strength Concrete</td>
<td>346</td>
</tr>
<tr>
<td>Josef Hegger and Claus Goralski</td>
<td></td>
</tr>
<tr>
<td>Slip in Composite Beams Using Typical Material Curves and the Effect of Changes in Beam Layout and Loading</td>
<td>356</td>
</tr>
<tr>
<td>Mike Banfi</td>
<td></td>
</tr>
<tr>
<td>Avoiding Fracture of Slab Reinforcement and Enhancing Ductility in Composite Beams</td>
<td>369</td>
</tr>
<tr>
<td>A. R. Kemp</td>
<td></td>
</tr>
</tbody>
</table>
**Composite Columns**

*New Design Method for Composite Columns Including High Strength Steel* .......... 381
  Reinhard Bergmann and Gerhard Hanswille

*Damage Assessment for Performance-Based Design of Rectangular Concrete-Filled Steel Tubes* ................................................................. 390
  Cenk Tort and Jerome F. Hajjar

*Load Introduction in Composite Columns with Concrete Filled Hollow Sections* .... 402
  Markus Porsch and Gerhard Hanswille

*The Behaviour of Circular Concrete-Filled Thin-Walled Steel Tubes in Flexure* ........ 412
  Andrew Wheeler and Russell Bridge

**Composite Structural Systems and Connections**

*Structural Characteristics of CFT Frames Consisting of Reusable Members* ........ 424
  Jun Kawaguchi, Shosuke Morino, Takanori Sato, and Kazuyuki Ohara

*Strength of CFT Connection Stiffened with T-Shaped Interior Diaphragms* ........ 431
  Ryoichi Kanno and Nobutaka Shimizu

*Behaviour of Semi-Rigid Composite Beam-Column Connections with Steel Beams and Precast Hollow Core Slabs* ............................................ 443
  D. Lam and F. Fu

*Component-Based Models of Dissipative Partial-Strength Beam-to-Column Composite Joints* .................................................................................. 455
  Walter Salvatore, Aurelio Braconi, and Oreste S. Bursi

**Practical Applications**

*The Miraflores Bridge over the River Guadalquivir in Córdoba (Spain)* .......... 467
  Julio Martínez Calzón

*Practical Experience with Composite Structures in the Netherlands* .......... 477
  Rob Stark and Remco Schuurman

*The Nelson Mandela Bridge as an Example of the Use of Composite Materials in Bridge Construction in South Africa* ........................................ 487
  Hennie Niehaus and Werner Jerling

**Shear Studs and Connectors**

*Channel Shear Connectors in Composite Beams: Push-Out Tests* ............ 501
  M. U. Hosain and Amit Pashan
The Shear Resistance and Ductility Requirements of Headed Studs Used with Profiled Steel Sheeting ................................................................. 511
Stephen Hicks and Graham Couchman

Residual Static Resistance of Welded Stud Shear Connectors .................. 524
Milan Veljkovic and Bernt Johansson

Structural Behaviour of Horizontally Lying Shear studs .......................... 534
Ulrike Kuhlmann and Kai Kürschner

Connection Behaviour of a Concrete Dowel in a Circular Web Hole of a Steel Beam ................................................................. 544
Simo Peltonen and Matti V. Leskelä

Experimental and Theoretical Research on a New Partial Adherence Shear Connection ................................................................. 553
Michel Thomann, Jean-Paul Lebet, and Hans Gerhard Dauner

The Cyclic Force-Slip Behavior of Headed Studs under Non Static Service Loads—Experimental Studies and Analytical Descriptions ........................................ 564
M. Feldmann, H. Gesella, and A. Leffer

Composite Beams with Nonlinear Material and Connector Behaviour for Low Degrees of Partial Shear Connection ................................................................. 573
Roland Bärtschi and Mario Fontana

Fire Resistance

Design of Composite Columns under High Temperatures with Special Consideration of Imperfections ................................................................. 583
Anja Kiesel and Jörg Lange

Fire Resistance Analysis of Open Car Parks with Composite Structures under Real Car Fire ................................................................. 595
Bin Zhao and Christophe Fraud

Effect of Differential Thermal Stresses on the Fire Resistance of Composite Columns with Hollow Sections ................................................................. 607
C. Renaud, J. M. Aribert, and B. Zhao

Seismic Behaviour and Design

The Next Generation of Coupling Beams ................................................................. 619
Patrick J. Fortney, Bahram M. Shahrooz, and Gian A. Rassati
Seismic Performance of End-Plate Moment Resisting Composite Joints................. 631
Alain Lachal, Jean-Marie Aribert, and Adrian Ciutina

Seismic Behavior of a 3D Full-Scale Steel-Concrete Composite Moment Resisting Frame Structure ................................................................. 641
Oreste S. Bursi, Riccardo Zandonini, Walter Salvatore, Stefano Caramelli, and Mike Haller

Contribution to the Design of Sway Composite Frames ..................................... 653
R. Maquoi, J. P. Jaspart, and J. F. Demonceau

Comparison between Seismic Behavior of 12- and 18-Story Hybrid Coupled Wall Systems .................................................................................... 664
Mohammad Hassan and Sherif El-Tawil

Interpretation of the Experimental Behavior of Two Semi-Rigid Composite Frames by Means of a By-Component Mechanical Model .......................... 674
Isaia Clemente, Roberto T. Leon, Salvatore Noé, and Gian A. Rassati

Performance-Based Design of Coupled Wall Systems ......................................... 686
Kent A. Harries, Bahram M. Shahrooz, Paul Brienen, Patrick J. Fortney, and Gian A. Rassati

Experimental Behaviour of Hollow and Filled RHS Bracing Members under Earthquake Loading ........................................................................... 698
Jamie M. Goggins, Brian M. Broderick, and Ahmed Y. Elghazouli

Seismic Response of Composite Structures Including Actual Behavior of Beam-to-Column Joints ........................................................................... 708
Jean-Marie Aribert, Adrian Liviu Ciutina, and Dan Dubina

Indexes

Subject Index ........................................................................................................... 719

Author Index ......................................................................................................... 721