

# Fib Bulletin 61

**Bond and anchorage of embedded reinforcement: Background to the fib Model Code for Concrete Structures 2010** fib - Fédération internationale du béton. 2014-05-01 As part of the preparation for the fib Model Code for Concrete Structures 2010, task group 4.5 Bond Models undertook a major review of rules for bond and anchorage of reinforcement in the CEB-FIP Model Code 1990. This bulletin presents the outcome of that review, describes the rationale for the revisions and presents the evidence on which the revisions are based. The principle changes in MC2010 include raising the limit on concrete strength that may be used when determining bond resistance to 110MPa, introduction of a coefficient  $\eta_4$  to cater for different reinforcement Classes, and coverage of new construction materials including epoxy coated and headed bars. The format of design rules has been changed to permit more rational treatment of confinement from concrete cover and transverse reinforcement, the contribution of end hooks and bends for tension bars, and end bearing to compression laps. New guidance is provided covering a range of construction techniques and service environments and the influence of long term degradation. Analyses of various aspects of detailing on performance of laps and anchorages have resulted in discontinuation of the 'proportion lapped' factor  $\alpha_6$ , alterations to requirements of transverse reinforcement at laps, and have resolved inconsistencies in provisions for bundled bars between major national codes. Apparent inconsistencies in existing rules for lapped joints and anchorages and between the local bond/slip model and design rules are also resolved, thus allowing integration of application rules and

modelling. Finally, the basis for an attempt to introduce simple detailing rules for laps and anchorages is described.

Stringer-Panel Models in Structural Concrete Johan Blaauwendraad.2018-06-26 Structural concrete designers nowadays distinguish between B-regions (named after Bernoulli beam theory) and D-regions (D standing for 'disturbed'). They are all familiar with B-regions, but less acquainted with the expertise required for D-regions. To design D-regions, the Strut-and-Tie Model (STM) is usually applied, a model laid down worldwide in structural codes of practice. The Stringer-Panel Model (SPM) recommended here is a companion method to the STM, with the advantage of being suitable for different load cases and reversed loading. This being so, the SPM is suitable for linear-elastic analyses where durability is a key consideration, but also suits structural design for contexts of cyclical seismic activity. Finally, this book sets out how structural engineers who prefer the STM can nevertheless apply the SPM to determine a proper strut-and-tie model.

**Condition Control and Assessment of Reinforced Concrete Structures Exposed to Corrosive Environments (carbonation/chlorides)** fib Fédération internationale du béton.2011-01-01 For the ongoing condition assessment of concrete structures, it is necessary to identify the extent, nature, cause and prognosis of any deterioration using a range of tools and methods, including prediction models. Combined with the original design and construction details, this gives a vast amount of information over a long time period. A framework concept is therefore needed to process the entirety of the information in order to make sound investment decisions on future maintenance management. To provide such a framework, fib Bulletin 59 summarizes information published in fib Bulletins 17, 22, 34 and 44 relevant to the control and assessment of reinforced concrete structures, and develops a practical concept of how, when and where to control the condition of an existing

concrete structure in order to facilitate structural management. Thus it gives a basis for processing relevant information in order to make decisions on the appropriate course of action for condition control.

*Strengthening the Rule of Law through the UN Security Council* Jeremy Farrall, Hilary Charlesworth. 2016-04-14 The UN Security Council formally acknowledged an obligation to promote justice and the rule of law in 2003. This volume examines the extent to which the Council has honoured this commitment when exercising its powers under the UN Charter to maintain international peace and security. It discusses both how the concept of the rule of law regulates, or influences, Security Council activity and how the Council has in turn shaped the notion of the rule of law. It explores in particular how this relationship has affected the Security Council's three most prominent tools for the maintenance of international peace and security: peacekeeping, sanctions and force. In doing so, this volume identifies strategies for better promotion of the rule of law by the Security Council. This book will be of interest to scholars and students of international law, international relations, international development and peacekeeping.

Precast-concrete buildings in seismic areas FIB - Féd. Int. du Béton. 2016 This document has a broad scope and is not focussed on design issues. Precast construction under seismic conditions is treated as a whole. The main principles of seismic design of different structural systems, their behavior and their construction techniques are presented through rules, construction steps and sequences, procedures, and details that should lead to precast structures built in seismic areas complying with the fundamental performance requirements of collapse prevention and life safety in major earthquakes and limited damage in more frequent earthquakes. The content of this document is largely limited to conventional precast construction and, although some information is provided on

the well-known “PRESSS technology” (jointed ductile dry connections), this latter solution is not treated in detail in this document. The general overview, contained in this document, of alternative structural systems and connection solutions available to achieve desired performance levels, intends to provide engineers, architects, clients, and end-users (in general) with a better appreciation of the wide range of applications that modern precast concrete technology can have in various types of construction from industrial to commercial as well as residential. Lastly, the emphasis on practical aspects, from conceptual design to connection detailing, aims to help engineers to move away from the habit of blindly following prescriptive codes in their design, but instead go back to basic principles, in order to achieve a more robust understanding, and thus control, of the seismic behaviour of the structural system as a whole, as well as of its components and individual connections.

Acceptance of Stay Cable Systems Using Prestressing Steels fib Fédération internationale du béton.2005-01-01 This fib Recommendation gives technical guidelines regarding design, testing, acceptance, installation, qualification, inspection and maintenance of stay cable systems using prestressing steels (strands, wires or bars) as tensile elements, which can be applied internationally. This Recommendation is applicable for cable-stayed bridges and other suspended structures such as roofs. It may also be used for hangers in arch structures and as suspension cables, as appropriate. This Recommendations has been formulated by an international working group comprising more than 20 experts from administrative authorities, universities, laboratories, owners, structural designers, suppliers of prestressing steels and stay cable suppliers. The text has been written to cover best construction practices around the world, and to provide material specifications that are considered to be the most advanced available at the time of preparing this text. For ease of use (for

client, designer and cable supplier), the complex content has been arranged thematically according to the system components into chapters focusing on performance characteristics, requirements and acceptance criteria. Requirements and comments have been specified for all parties involved in design and construction in order to aim for a uniform and high quality and durability. The interfaces to the structural designer are highlighted. The essential subjects are: Design and detailing of stay cables including saddles and damping devices Durability requirements and corrosion protection systems Requirements for the materials Testing requirements for the stay cables Installation, tolerances, qualification of companies and personnel Inspection, maintenance and repair. This Recommendation does not cover the technology of stay cables whose tensile elements are ropes, locked-coil cables, etc. or which consist of composite materials. Nevertheless, in many cases the specified performance criteria may also be applicable to these systems, although numerical values given for the acceptance criteria may need to be adjusted. For these systems it has been difficult to provide multiple protective layers similar to those specified for stay cables made from prestressing steel and therefore, the quality of corrosion protection may not be equivalent. While extradosed cables have similarities with stay cables, generally agreed design and system acceptance criteria are not yet available and therefore, this type of cable is not covered.

**Externally applied FRP reinforcement for concrete structures** FIB - International Federation for Structural Concrete.2019-05-01 In December 1996, CEB established a Task Group with the main objective to elaborate design guidelines for the use of FRP reinforcement in accordance with the design format of the CEB-FIP Model Code and Eurocode2. With the merger of CEB and FIP into fib in June 1998, this Task Group became fib TG 9.3 FRP Reinforcement for concrete structures in Commission 9 Reinforcing and Prestressing Materials and Systems. Finally, as a result of the

restructuring of fib's Commissions and Task Groups at the end of 2014, the Task Group became fib T5.1 FRP Reinforcement for concrete structures, chaired by Stijn Matthys at Ghent University, in Commission 5 Reinforcements. The work of former TG 9.3 and current T5.1 was performed by two working parties (WP), one of which is "Externally Applied Reinforcement" (EAR), which produced fib bulletin 14 "Externally bonded FRP reinforcement for RC structures" in July 2001. Following a number of years of relatively slow activity, the WP on externally applied reinforcement was reactivated and started working on an update of bulletin 14. The result of this work is summarised in the present technical report, which aims to give design guidelines on the use of externally applied FRP reinforcement (both externally bonded and near-surface mounted) for concrete structures. An attempt has been made to present some of the topics in a Eurocode-compatible format, so that the material covered may form the basis for the introduction of composites in the next version of Eurocode 2 and for the updating of the text on seismic retrofitting with composites in the next version of Eurocode 8. All persons who participated in the preparation of this Bulletin are mentioned in the copyright page. Further acknowledgements are due to Josée Bastien (Canada), Hans Rudolf Ganz (Switzerland) and Luc Taerwe (Belgium) for revision of the document. To all members of the working party on externally applied reinforcement our sincere thanks are expressed for the high quality and extensive work brought in on a voluntary basis.

*10th PhD Symposium in Quebec Canada* FIB - International Federation for Structural Concrete.2014-07-01

Model Code 2010 - First complete draft - Volume 2 fib Fédération internationale du béton.2010-01-01 The Model Code for Concrete Structures is intended to serve as a basis for future codes. It takes into account new developments with respect to concrete structures, the structural

material concrete and new ideas for the requirements to be formulated for structures in order to achieve optimum behaviour according to new insights and ideas. It is also intended as a source of information for updating existing codes or developing new codes for concrete structures. At the same time, the Model Code is intended as an operational document for normal design situations and structures.

*Proceedings fib Symposium in Tel-Aviv Israel* FIB – International Federation for Structural Concrete.2013-04-01

*A State-of-the-Art Guide for Post-Installed Reinforcement* Daniel TW Looi,Ray KL Su,Emad Gad.2022-07-22 A State-of-the-Art Guide for Post-Installed Reinforcement provides comprehensive coverage on installation, design, and assessment guidelines for post-installed reinforcements, a unique technology used very commonly in the construction industry. Previously published in Hong Kong, this Malaysian edition includes new EOTA technical reports and European Assessment Documents, fundamentals for post-installed reinforcements, design proposals, as well as unique design examples, all of which is specifically tailored for the Malaysian context.

**Monthly Statistical Bulletin** Pakistan. Statistics Division.2002

**Monthly Bulletin of Statistics** .2018-10

Corrosion and Protection of Reinforced Concrete Brian Cherry,Warren Green.2021-03-17 Reinforced concrete is the most widely used construction material in the world, and extended performance is rightly expected. Many structures are in aggressive environments, of critical importance and may be irreplaceable, so repair and protection are vital. This book surveys deterioration of concrete, particularly corrosion of the steel reinforcement, and the various chemical, biological, physical and mechanical causes of deterioration. It outlines condition survey and diagnosis techniques by on-site

and laboratory measurements. It sets out mechanical methods of protection and repair, such as patching, inhibitors, coatings, penetrants and structural strengthening as well as cathodic protection and other electrochemical methods. This book also gives guidance on preventative measures including concrete technology and construction considerations, coatings and penetrants, alternate reinforcement, permanent corrosion monitoring and durability planning aspects. Asset managers, port engineers, bridge maintenance managers, building managers, heritage structure engineers, plant engineers, consulting engineers, architects, specialist contractors and construction material suppliers who have the task of resolving problems of corrosion of steel reinforced concrete elements will find this book an extremely useful resource. It will also be a valuable reference for students at postgraduate level. Authors The late Professor Brian Cherry of Monash University, Melbourne, Australia was one of the world's leading corrosion science and engineering educators and researchers. Warren Green of Vinsi Partners, Sydney, Australia is a corrosion engineer and materials scientist. He is also an Adjunct Associate Professor.

*Extradosed Bridges* Andreas Apitz, Thierry Duclos, Akio Kasuga, José Romo Martín, Serge Montens, Chithambaram Sankaralingam, Juan Sobrino. 2020-01-20 Extradosed bridges can be an elegant and economic solution for bridges with spans ranging between 100 and 250m. This novel type of cable-supported bridges has become quite successful in recent years first in Japan and then all over the world. Experienced members of the international bridge community have come together in Working Commission 3 of IABSE to share their knowledge and to prepare an SED which provides the reader with guidance and practical advice that was not available so far. This book contains useful information regarding conceptual and structural design, analysis, construction, cost and typical properties of Extradosed Bridges.



Precast Concrete Structures Kim S. Elliott.2019-08-08 This second edition of Precast Concrete Structures introduces the conceptual design ideas for the prefabrication of concrete structures and presents a number of worked examples that translate designs from BS 8110 to Eurocode EC2, before going into the detail of the design, manufacture, and construction of precast concrete multi-storey buildings. Detailed structural analysis of precast concrete and its use is provided and some details are presented of recent precast skeletal frames of up to forty storeys. The theory is supported by numerous worked examples to Eurocodes and European Product Standards for precast reinforced and prestressed concrete elements, composite construction, joints and connections and frame stability, together with extensive specifications for precast concrete structures. The book is extensively illustrated with over 500 photographs and line drawings.

*Advances on bond in concrete* FIB - International Federation for Structural Concrete.2022-12-01 Structural behavior of reinforced concrete elements strongly depends on the interaction between the reinforcing bars and the surrounding concrete, which is generally referred as “bond in concrete”. In service conditions, the reinforcement-to-concrete bond governs deformability through the tension stiffening of concrete surrounding the bar as well the crack development and crack width. At Ultimate Limit State, bond governs anchorage and lap splices behavior as well as structural ductility. When plain (smooth) bars were used, the steel-to-concrete bond was mainly associated with “chemical adhesion/friction” that is related to the surface roughness of the rebar. As steel strengths increased the need to enhance interaction between steel and the surrounding concrete was recognized, and square twisted rebars, indented rebars or, later on, ribbed rebars came into the market, the latter being the type of deformed bar most commonly adopted since the 1960/70s. When ribbed rebars became widely used, several research studies started worldwide for

better understanding the interaction between ribs and the surrounding concrete. Researchers evidenced the development of micro-cracks (due to the wedge action of the ribs) towards the external face of the structural element. If confinement is provided by the concrete cover, by transverse reinforcement or by an external transverse pressure, the full-anchorage capacity is guaranteed and a pull-out failure occurs, with crushing of concrete between the ribs. On the contrary, with lesser confining action, a splitting failure of bond occurs; the latter may provoke a brittle failure of the lap splice or, in some cases, of anchorages. However, after many years of research studies on bond-related topics, there are still several open issues. In fact, new materials entered into the market, as concrete with recycled aggregates or fibre reinforced concrete; the latter, having a kind of distributed reinforcement into the matrix (the fibres), provides a better confinement to the wedge action of the ribs. In addition, concrete and steel strength continuously increased over the years, causing changes in the bond behavior due to differences in mechanical properties of materials but also to the different concrete composition at the interface with the steel rebar causing a different bond behavior. Moreover, the lower water/cement ratio of these high-strength concrete makes the bleeding phenomena less evident, changing the concrete porosity in the upper layers of the structural element and thus making the current casting position parameters no longer reliable. Finally, concrete with recycled aggregates are becoming more important in a market that is looking forward to a circular economy. As such, all the experimental results and database that allowed the calibration of bond rules now present in building codes for conventional concrete, may be not be representative of these new types of materials nowadays adopted in practice. Furthermore, after more than 50 years of service life, structural elements may not satisfy the current safety requirements for several reasons, including material degradation (with particular

reference to steel corrosion) or increased loads, by also considering the seismic actions that were non considered by building codes at the time of the original design. The structural assessment of existing structures requires proper conceptual models and new approaches for evaluating the reliability of existing structures by also considering the remaining expected service life. In addition, specific rules for older materials, as plain smooth bars, should be revised for a better assessment of old structures. Last, but not least, interventions in existing structures may require new technologies now available such as post-installed rebars. While many advances have been achieved, there remain areas where a better understanding of bond and its mechanisms are required, and where further work is required to incorporate this understanding into safe and economic rules to guide construction and maintenance of existing infrastructures. These aspects were widely discussed within the technical community, particularly in the fib Task Group 2.5 and in the ACI 408 Committee dealing with bond and anchorage issues. Furthermore, special opportunities for discussing bond developments were represented by the International Conferences on 'Bond in Concrete' held each decade since 1982 as well as by joint workshops organized by fib TG2.5 and ACI 408. Within this technical collaboration, this Bulletin was conceived, and, thus, it collects selected papers presented at the joint fib-ACI Convention Session on Bond in Concrete held in Detroit (USA) in 2017. The bulletin is based on four main Sections concerning: - General aspects of bond - Anchorages and laps of bars and prestressing tendons - Bond under severe conditions - Degradation of bond for corrosion - Bond in new types of concrete The main aim of the Bulletin is to shed some new lights on the advances in understanding and application of bond related issues achieved over the last few years, and identify the challenges and priorities to be addressed in the next years. Another important aspect of the bulletin is to provide practical information from research findings.

## **External Tendons for Bridges** FIB - International Federation for Structural Concrete.2020-12-01

The concept of post-tensioning has been recognized for over a century. Interestingly, early developments started with external tendons, but failed to be recognized as a major construction technique for two main reasons: - Low tensile performance of early steels in combination with a poor knowledge of concrete creep and shrinkage properties, - Lack of a durable corrosion protection. With the technological progress, external tendons became increasingly popular in the 1980's, as a post-tensioning method enabling inspection and, if necessary, replacement of tendons without demolition of structural members. Towards the end of the last century, more than 50 bridges have been built with external tendons, first in France and soon gaining traction in other countries. FIP published a state-of-the-art report in May 1996 to provide a review of the application of external tendons, describing specific material problems and methods for dealing with them. 25 years have passed and, while the engineering principles covered by the FIP report remain unchanged, the context has evolved: - External tendons and construction methods have kept evolving with better materials, ever longer spans, and tighter schedules. - Normalization frame in Europe changed, Severe durability issues have occurred in some countries from which the industry can extract good knowledge of the causes and how to avoid similar problems in the future. This new fib bulletin has been prepared with the aim to reflect the current state of the art and encompass the knowledge amassed in the last quarter of century with chapters covering from the design and approval of systems and materials to installation, quality control and monitoring. The last chapter is a compilation of structures worldwide covering all sorts of materials, typologies and construction methods, which might be a source of inspiration for owners and designers alike.

## **Recycled Aggregate Concrete** Natt Makul.2023-04-26 Recycled Aggregate Concrete (RAC) as a

sustainable material is gaining increasing importance in the construction industry. This book discusses properties, specifications, and applications of RAC and offers readers insight into current research and advances in the development and utilization of RAC. It shares information gathered about concretes that use RCA (Recycled Concrete Aggregate, a component of RAC), as well as findings and conclusions. This book:

- Presents principles of RAC, including theories and experiments
- Describes advanced behavior and properties
- Covers specifications and codes
- Highlights best practices
- Summarizes the use of RAC in sustainable concrete construction
- Features scientific findings, citations of reliable sources, conclusions, and recommendations that ensure the book is accessible to various levels of expertise

This book will be useful for researchers, concrete scientists, technologists, practicing engineers, and advanced students interested in reusing construction waste for sustainable construction practices; it will help them strive toward meeting the UN Sustainable Development Goals (SDGs).

**Fibre Reinforced Concrete: From Design to Structural Applications** FIB - International Federation for Structural Concrete. 2020-08-01 The first international FRC workshop supported by RILEM and ACI was held in Bergamo (Italy) in 2004. At that time, a lack of specific building codes and standards was identified as the main inhibitor to the application of this technology in engineering practice. The workshop aim was placed on the identification of applications, guidelines, and research needs in order for this advanced technology to be transferred to professional practice. The second international FRC workshop, held in Montreal (Canada) in 2014, was the first ACI-fib joint technical event. Many of the objectives identified in 2004 had been achieved by various groups of researchers who shared a common interest in extending the application of FRC materials into the realm of structural engineering and design. The aim of the workshop was to provide the State-of-the-

Art on the recent progress that had been made in term of specifications and actual applications for buildings, underground structures, and bridge projects worldwide. The rapid development of codes, the introduction of new materials and the growing interest of the construction industry suggested presenting this forum at closer intervals. In this context, the third international FRC workshop was held in Desenzano (Italy), four years after Montreal. In this first ACI-fib-RILEM joint technical event, the maturity gained through the recent technological developments and large-scale applications were used to show the acceptability of the concrete design using various fibre compositions. The growing interests of civil infrastructure owners in ultra-high-performance fibre-reinforced concrete (UHPC) and synthetic fibres in structural applications bring new challenges in terms of concrete technology and design recommendations. In such a short period of time, we have witnessed the proliferation of the use of fibres as structural reinforcement in various applications such as industrial floors, elevated slabs, precast tunnel lining sections, foundations, as well as bridge decks. We are now moving towards addressing many durability-based design requirements by the use of fibres, as well as the general serviceability-based design. However, the possibility of having a residual tensile strength after cracking of the concrete matrix requires a new conceptual approach for a proper design of FRC structural elements. With such a perspective in mind, the aim of FRC2018 workshop was to provide the State-of-the-Art on the recent progress in terms of specifications development, actual applications, and to expose users and researchers to the challenges in the design and construction of a wide variety of structural applications. Considering that at the time of the first workshop, in 2004, no structural codes were available on FRC, we have to recognize the enormous work done by researchers all over the world, who have presented at many FRC events, and convinced code bodies to include FRC among the reliable alternatives for

structural applications. This will allow engineers to increasingly utilize FRC with confidence for designing safe and durable structures. Many presentations also clearly showed that FRC is a promising material for efficient rehabilitation of existing infrastructure in a broad spectrum of repair applications. These cases range from sustained gravity loads to harsh environmental conditions and seismic applications, which are some of the broadest ranges of applications in Civil Engineering. The workshop was attended by researchers, designers, owner and government representatives as well as participants from the construction and fibre industries. The presence of people with different expertise provided a unique opportunity to share knowledge and promote collaborative efforts. These interactions are essential for the common goal of making better and sustainable constructions in the near future. The workshop was attended by about 150 participants coming from 30 countries. Researchers from all the continents participated in the workshop, including 24 Ph.D. students, who brought their enthusiasm in FRC structural applications. For this reason, the workshop Co-chairs sincerely thank all the enterprises that sponsored this event. They also extend their appreciation for the support provided by the industry over the last 30 years which allowed research centers to study FRC materials and their properties, and develop applications to making its use more routine and accepted throughout the world. Their important contribution has been essential for moving the knowledge base forward. Finally, we appreciate the enormous support received from all three sponsoring organizations of ACI, fib and Rilem and look forward to paving the path for future collaborations in various areas of common interest so that the developmental work and implementation of new specifications and design procedures can be expedited internationally. Towards a rational understanding of shear in beams and slabs fib Fédération internationale du béton.2018-05-01 Reliable performance of beams and slabs in shear is essential for the safety and

also for the serviceability of reinforced concrete structures. A possible failure in shear is usually a brittle failure, which underlines the importance of the correct specification of the load carrying capacity in shear. The knowledge of performance in shear is steadily developing and it is now obvious that older structures were not always designed in accordance with contemporary requirements. The increasing load - mainly on bridges - requires the assessment of existing structures, often followed by their strengthening. An appropriate understanding of actual performance of concrete structures in shear is therefore of primary interest. The workshop which was held in Zürich in 2016 brought together a significant number of outstanding specialists working in the field of shear design, who had a chance to exchange their opinions and proposals for improving the current knowledge of shear behaviour in beams and slabs. The specialists came from different parts of the world, which made the workshop general and representative. The workshop was organised by fib Working Party 2.2.1 "Shear in Beams" (convened by O. Bayrak), which is a part of fib Commission 2 Analysis and Design. Individual contributions mainly address shear in beams with low transversal reinforcement. It is crucial because many existing structures lack such reinforcement. Different theories, e.g. Critical Shear Crack Theory (CSCT), Modified Compression Field Theory (MCFT), Multi-Action Shear Model (MASM), etc. were presented and compared with procedures used in selected national codes or in the fib Model Code 2010. The models for shear design were often based to a great extent on empirical experience. The refined presented models tend to take into account the physical mechanisms in structures more effectively. A brittle behaviour in shear requires not only to check the equilibrium and failure load, but also to follow the progress of failure, including the crack development and propagation, stress redistribution, etc. The significance of the size effect - which causes the nominal strength of a large structure to be smaller than that of



a small structure – was pointed out. Nowadays, the fibre reinforcement is used more than before since it allows significant labour costs savings in the construction industry. The contribution of fibres is suitable for shear transfer. It is very convenient that not only ordinary fibre reinforced elements were addressed but also the UHPFRC beams. The production of this new material is indeed growing, while the development of design recommendations has not been sufficiently fast. Fatigue resistance of structures with low shear reinforcement is also an important issue, which was also addressed in this bulletin. It cannot be neglected in prestressed bridges, which are exposed to dynamic loads. A comprehensive understanding of the shear behaviour is necessary. Although many laboratory experiments are carried out, they are suitable only to a limited extent. New testing methods are being developed and show promising results, e.g. digital image correlation. An actual structure performance should rather be tested on a large scale, ideally on real structures under realistic loading conditions.ii The papers presented in the bulletin are a basis for the discussion in view of the development of updated design rules for the new fib Model Code (MC2020), which is currently under preparation. fib Bulletins like this one, dealing with shear, help to transfer knowledge from research to design practice. The authors are convinced that it will lead to better new structures design of as well as to savings and to a safety increase in older existing structures, whose future is often decided now.

**Soft Ground Tunnel Design** Benoit Jones.2021-11-16 Soft Ground Tunnel Design is a textbook that teaches the principles of tunnel and underground space design in soft ground. ‘Soft ground’ refers to soil, in contrast to rock. The book focuses on stability, prediction of ground movements and structural design of the lining. It shows that the choice of excavation and support methods depends on ground stability; limitation of damage to the existing built environment; and health, safety and

environmental considerations. Author Benoît Jones builds on the basic principles of soil-structure interaction, the three-dimensional effects of construction sequence and the effects of construction on other surface or subsurface structures in steps of gradually increasing complexity. The use of worked examples throughout, and example problems at the end of each chapter, gives the reader confidence to apply their knowledge. Engineers and graduate students will be able to:

- Understand the complex soil-structure interaction around an advancing tunnel.
- Calculate heading stability.
- Understand the basis for choosing an underground construction method and/or ground improvement method.
- Design tunnel linings in soft ground using a variety of methods.
- Predict ground movements.
- Predict the effects of construction on the built environment and assess potential damage.

Benoît Jones has worked in tunnelling as a designer, contractor and academic for more than 20 years. He set up and ran the MSc Tunnelling and Underground Space course at the University of Warwick. He is now managing director of his own company, Inbye Engineering.

*Proceedings fib Symposium in Athens Greece FIB - International Federation for Structural Concrete.*2003-05-01

**Design of Hybrid Structures** André Plumier, Hervé Degée.2023-05-09 Well-designed hybrid structures can combine the different performance strengths materials. This guide focuses on design approaches for concrete structures reinforced in an unconventional way by steel profiles. It explains force transfer mechanisms of steel profiles and oncrete interfaces, and an analysis of the characteristics of hybrid structures, including slendercomponents. Several types of hybrid designs are addressed: walls and columns with several embedded steel profiles, connections strengthened by steel profiles between steel and composite or reinforced concrete components, including the specific case of shear keys connecting deep beams or flat slabs to columns. The transition zones in partly

reinforced concrete and partly composite columns are also covered. Design of Hybrid Structures draws on the European SMARTCOCO research project of experimentation and numerical modelling, giving practical guidance for designers and introducing the subject for researchers and graduate students.

### **Nordic Concrete Research .2003**

#### **Self-Compacting Concrete: Materials, Properties and Applications** Rafat Siddique.2019-11-19

Self-Compacting Concrete: Materials, Properties and Applications presents the latest research on various aspects of self-compacting concrete, including test methods, rheology, strength and durability properties, SCC properties at elevated temperature, SC manufacturing with the use of SCMs, recycled aggregates and industrial by-products. Written by an international group of contributors who are closely associated with the development of self-compacting concrete, the book explores the main differences between SCC and normal concrete in terms of raw materials, fresh properties and hardened properties. Other topics discussed include the structure and practical applications of fiber reinforced SCC. Researchers and experienced engineers will find this reference to be a systematic source to SCC with its accounting of the latest breakthroughs in the field and discussions of SCC constructability, structural integrity, improved flows into complex forms, and superior strength and durability. Offers a systematic and comprehensive source of information on the latest developments in SCC technology Includes mix design procedures, tests standards, rheology, strength and durability properties Explores the properties and practical applications of SCC

**Serviceability Limit State of Concrete Structures** FIB - International Federation for Structural Concrete.2019-09-01 Serviceability limit states are essential for appropriate function and durability

of concrete structures. The attention is paid especially to the stress limitation, crack width analysis and deflection analysis. The document provides supplementary information to the fib Model Code 2010 (MC2010), where a limited space did not allow for a detailed description of individual procedures. The principles used in MC2010 in chapter 7.6 are explained in detail within this document. The stress analysis is focused on stresses in concrete and steel including the stress redistribution due to the long-term load and cracking of reinforced concrete and prestressed concrete elements. Crack width analysis explains the mechanism of cracking under mechanical loading and due to deformation restraint. Cracks in prestressed concrete elements are also discussed. Deflection analyses with different levels of accuracy are described including the shear effects. Examples illustrate the practical application of rules defined in the MC2010 of individual serviceability limit states. Simplified and more general methods are used. An important part of the bulletin shows the development and extension of the serviceability limit states after publishing of the MC2010 and alternative approaches. Special attention is paid to deflections of prestressed concrete beams, shear effects on deflection, slenderness limits and influence of the concrete cover. The final part deals with an application of numerical simulations.

**High Tech Concrete: Where Technology and Engineering Meet** D.A. Hordijk, M.

Luković.2017-06-08 This book contains the proceedings of the fib Symposium “High Tech Concrete: Where Technology and Engineering Meet”, that was held in Maastricht, The Netherlands, in June 2017. This annual symposium was organised by the Dutch Concrete Association and the Belgian Concrete Association. Topics addressed include: materials technology, modelling, testing and design, special loadings, safety, reliability and codes, existing concrete structures, durability and life time, sustainability, innovative building concepts, challenging projects and historic concrete, amongst

others. The fib (International Federation for Structural Concrete) is a not-for-profit association committed to advancing the technical, economic, aesthetic and environmental performance of concrete structures worldwide.

**Design of FRP and Steel Plated RC Structures** Deric Oehlers, Rudolph Seracino. 2004-09-11

There are a large and ever-increasing number of structures and buildings worldwide that are in need of refurbishment, rehabilitation and strengthening. The retrofitting of beams and slabs for this purpose is now recognized as the most cost-effective and environmentally sustainable method of carrying out this essential renovation work. The authors of Design of FRP and Steel Plated RC Structures are both acknowledged world experts on these techniques and their book has been designed to provide the reader with a comprehensive overview of the established techniques and their applications as well as thorough coverage of newly emerging methodologies and their uses. The comparison of FRP and steel is a particular focus and the authors provide practical examples of where one material might be used in preference to another. Indeed practical, worked examples of how, when, and why specific solutions have been chosen in real-world situations are used throughout the text and provide the user with invaluable insights into the decision-making process and its technical background. Just as importantly these examples make the understanding and application of these techniques easier to understand for the student and the practitioner. The book is international in appeal, as while no reference is made to specific local codes the authors' approach always follows that of the more advanced structural codes worldwide. As such it will remain an essential resource for many years to come. Design of FRP and Steel Plated RC Structures is an important reference for a broad range of researchers, students and practitioners including civil engineers and contractors, architects, designers and builders. Contains detailed worked examples

throughout to aid understanding and provide technical insight Covers all types of metal plates and all types of FRP plates Uses design philosophies that can be used with any mathematical model Provides coverage of all main international guidelines

**1st fib Congress in Osaka Japan Vol2** FIB - International Federation for Structural Concrete.2002-01-01

**Structural Connections for Precast Concrete Buildings** fib Fédération internationale du béton.2008-01-01 Connections are among the most essential parts in precast structures. Their performance relates to the structural limit states, as well as to manufacture of the precast elements and erection and maintenance of the structure itself. Proper design of connections is one major key to a successful prefabrication. The principal aim of fib Bulletin 43 is to encourage good practice in the design of structural connections in precast concrete structures. This is achieved through a good understanding of structural connections as parts of the overall structural system and of basic force transferring mechanisms. The bulletin consists of two parts; the first part concerns general considerations and philosophy in the design of structural connections, and the second part deals with basic force transferring mechanisms within structural connections. The main focus is on the design of structural connections with regard to their structural function in ordinary design situations in the serviceability and ultimate limit states, and in accidental/abnormal design situations, like fire, lack of fit and impact/accidental loads. Other aspects considered include production, handling and site erection of elements, building physics, durability and maintenance. Bulletin 43 applies to structural connections for precast concrete buildings, although the information on basic force transfer mechanisms can also be applicable to other types of prefabricated structures.

Design Examples for Strut-and-tie Models fib Fédération internationale du béton.2011 fib Bulletin 61

is a continuation of fib Bulletin 16 (2002). Again the bulletin's main objective is to demonstrate the application of the FIP Recommendations "Practical Design of Structural Concrete", and especially to illustrate the use of strut-and-tie models to design discontinuity regions (D-regions) in concrete structures. Bulletin 61 presents 14 examples, most of which are existing structures built in recent years. Although some of the presented structures can be considered to be quite important and, in some instances, complex, the chosen examples are not intended to be exceptional. The main aim is to look at specific design aspects, by selecting D-regions of the presented structures that are designed and detailed according to the proposed design principles and specifications for the use of strut-and-tie models. Two papers at the end of the bulletin deal with the role of concrete tension fields in modelling with strut-and-tie models, and summarize the experiences gained by the Working Group in applying strut-and-tie models to the examples in the bulletin. It is hoped that fib Bulletin 61 will be of interest to engineers involved in the design of concrete structures, supporting the use of more consistent design and detailing tools such as strut-and-tie models.

Environmental Effects of Concrete fib Fédération internationale du béton.2003-01-01 The report has been elaborated by Task Group 3.4 Environmental effects of concrete of fib Commission 3 Environmental aspects of design and construction. It intends to serve as a source of information on the generally accepted and proven state of knowledge about environment related aspects of concrete as a structural material. It is written for engineers as a state-of-art-report and represents a comprehensive summary of the relevant literature and knowledge known by and available to the members of the Task Group. For this reason it is to a certain degree influenced by the approaches and generally accepted views in the countries where the members of the Task Group came from. Discussions related to risks arising from the release of substances, radiation or noise into the

environment, and appropriate limit values to avoid problems or implications on sustainability, are in general very controversial, and, in different parts of the world, developed to a different degree. Similarly the approaches and regulatory measures to ensure the general requirements of sustainable construction are still under development and may be extremely different in various countries. For these reasons no assessment and judgement systems related to environmental risks will be proposed, nor will limit values be given. The report is established on a factual basis and may help to avoid controversial discussions and emotional judgements, and may serve as a basis to derive accepted requirements. The length of the various chapters does not correspond to the importance or the risks related to the treated aspects. It simply depends on the information and amount of data available to the Task Group.

*Acceptance of cable systems using prestressing steels* FIB – International Federation for Structural Concrete. 2019-03-01 Cable-stayed structures have become increasingly popular over the last 30 years and have been used in all parts of the world. Modern cable-stayed bridges have a history of over 50-years and have been constructed with span lengths ranging from 15 m to over 1000 m. Many long span cable-stayed bridges have been built for railway and highway traffic applications. Stay cables have also been used on pedestrian structures, many of which are architecturally striking and have become landmark structures. There is growing use in building structures, particularly for cable-supported roofs. Most of the cable supported structures have been in the form of cable-stayed bridges; but in recent years, extradosed bridges have seen increased popularity among the designers. Led by the experience in Japan, more than 200 extradosed bridges have been constructed worldwide in the past 15 years. The first edition of these fib recommendations was published as fib Bulletin 30 in 2005 and was the first specification published by fib for stay cable systems. This new



bulletin has been updated based on Bulletin 30 with the aim to reflect the current state of the art and encompass the latest knowledge in cable systems. In addition, it has been the aspiration of Commission 5 and Task Group 5.5 to harmonize the guidance in this updated bulletin with other stay cable recommendations from around the world, including those from Europe, Japan and the USA. This new bulletin is intended to supersede and replace fib Bulletin 30. It is recommended that it be used in lieu of fib Bulletin 30 for all future cable supported applications. The updated bulletin introduces several significant enhancements to the specifications: These recommendations are applicable to both stay cable and extradosed cable applications. In the past, there has been some debate over the boundary between cable-stayed and extradosed bridges. This bulletin presents a new continuous approach valid for both. A completely new testing requirement to assess the performance of cable systems under bending fatigue, including both anchorages and saddles, if applicable, has been added. Testing requirements for saddle systems have been reformulated. In addition to the bending fatigue test noted above, new testing procedures for stay cable saddles with isolated tensile elements are introduced. This includes tests for saddle axial fatigue, friction and tensile testing, and determination of the effective saddle friction coefficient. Expanded system qualification, including requirements for both stay cable and extradosed applications. Includes new provisions for MTE qualification and additional load transferring connection devices. Minimum number of tests is specified for each. A new in-situ damping measurement test has been added to verify the actual damping ratio of the damping devices installed. By testing on site, selected cables may be excited to vibrate without and with the damping devices so that the observed v vibration behaviour can be compared to the specified value. Other revisions have been made to reflect the current state of practice: Expanded quality control testing requirements Inclusion of epoxy-coated

prestressing steel as a protection layer. Previous recommendations only considered zinc coatings. Specifications for epoxy coating material are given. Requirements for stainless steel components such as pipes, caps and plates Updated guidance for designing lightning protection systems Detailed recommendations for different levels of inspection of cable systems, including: initial, routine, detailed and exceptional inspections An updated list of references, relevant standards, and extended literature

Structural Concrete, Volume 2 fib Fédération internationale du béton.2010-01-01 The second edition of the Structural Concrete Textbook is an extensive revision that reflects advances in knowledge and technology over the past decade. It was prepared in the intermediate period from the CEP-FIP Model Code 1990 (MC90) to fib Model Code 2010 (MC2010), and as such incorporates a significant amount of information that has been already finalized for MC2010, while keeping some material from MC90 that was not yet modified considerably. The objective of the Textbook is to give detailed information on a wide range of concrete engineering from selection of appropriate structural system and also materials, through design and execution and finally behaviour in use. The revised fib Structural Concrete Textbook covers the following main topics: phases of design process, conceptual design, short and long term properties of conventional concrete (including creep, shrinkage, fatigue and temperature influences), special types of concretes (such as self compacting concrete, architectural concrete, fibre reinforced concrete, high and ultra high performance concrete), properties of reinforcing and prestressing materials, bond, tension stiffening, moment-curvature, confining effect, dowel action, aggregate interlock; structural analysis (with or without time dependent effects), definition of limit states, control of cracking and deformations, design for moment, shear or torsion, buckling, fatigue, anchorages, splices, detailing; design for durability

(including service life design aspects, deterioration mechanisms, modelling of deterioration mechanisms, environmental influences, influences of design and execution on durability); fire design (including changes in material and structural properties, spalling, degree of deterioration), member design (linear members and slabs with reinforcement layout, deep beams); management, assessment, maintenance, repair (including, conservation strategies, risk management, types of interventions) as well as aspects of execution (quality assurance), formwork and curing. The updated Textbook provides the basics of material and structural behaviour and the fundamental knowledge needed for the design, assessment or retrofitting of concrete structures. It will be essential reading material for graduate students in the field of structural concrete, and also assist designers and consultants in understanding the background to the rules they apply in their practice. Furthermore, it should prove particularly valuable to users of the new editions of Eurocode 2 for concrete buildings, bridges and container structures, which are based only partly on MC90 and partly on more recent knowledge which was not included in the 1999 edition of the Textbook.

*fib Model Code for Concrete Structures 2010* fib - federation internationale du beton.2013-12-04 The International Federation for Structural Concrete (fib) is a pre-normative organization. 'Pre-normative' implies pioneering work in codification. This work has now been realized with the fib Model Code 2010. The objectives of the fib Model Code 2010 are to serve as a basis for future codes for concrete structures, and present new developments with regard to concrete structures, structural materials and new ideas in order to achieve optimum behaviour. The fib Model Code 2010 is now the most comprehensive code on concrete structures, including their complete life cycle: conceptual design, dimensioning, construction, conservation and dismantlement. It is expected to become an important document for both national and international code committees, practitioners

and researchers. The fib Model Code 2010 was produced during the last ten years through an exceptional effort by Joost Walraven (Convener; Delft University of Technology, The Netherlands), Agnieszka Bigaj-van Vliet (Technical Secretary; TNO Built Environment and Geosciences, The Netherlands) as well as experts out of 44 countries from five continents.

**Structural Concrete Textbook, Volume 4** fib Fédération internationale du béton.2010-06-01 The second edition of the Structural Concrete Textbook is an extensive revision that reflects advances in knowledge and technology over the past decade. It was prepared in the intermediate period from the CEP-FIP Model Code 1990 (MC90) to fib Model Code for Concrete Structures 2010 (MC2010), and as such incorporates a significant amount of information that has been already finalized for MC2010, while keeping some material from MC90 that was not yet modified considerably. The objective of the textbook is to give detailed information on a wide range of concrete engineering from selection of appropriate structural system and also materials, through design and execution and finally behaviour in use. The revised fib Structural Concrete Textbook covers the following main topics: phases of design process, conceptual design, short and long term properties of conventional concrete (including creep, shrinkage, fatigue and temperature influences), special types of concretes (such as self compacting concrete, architectural concrete, fibre reinforced concrete, high and ultra high performance concrete), properties of reinforcing and prestressing materials, bond, tension stiffening, moment-curvature, confining effect, dowel action, aggregate interlock; structural analysis (with or without time dependent effects), definition of limit states, control of cracking and deformations, design for moment, shear or torsion, buckling, fatigue, anchorages, splices, detailing; design for durability (including service life design aspects, deterioration mechanisms, modelling of deterioration mechanisms, environmental influences, influences of design and execution on

durability); fire design (including changes in material and structural properties, spalling, degree of deterioration), member design (linear members and slabs with reinforcement layout, deep beams); management, assessment, maintenance, repair (including, conservation strategies, risk management, types of interventions) as well as aspects of execution (quality assurance), formwork and curing. The updated textbook provides the basics of material and structural behaviour and the fundamental knowledge needed for the design, assessment or retrofitting of concrete structures. It will be essential reading material for graduate students in the field of structural concrete, and also assist designers and consultants in understanding the background to the rules they apply in their practice. Furthermore, it should prove particularly valuable to users of the new editions of Eurocode 2 for concrete buildings, bridges and container structures, which are based only partly on MC90 and partly on more recent knowledge which was not included in the 1999 edition of the textbook.

**Fibre Reinforced Concrete** FIB - International Federation for Structural Concrete.2022-11-01  
Fibre Reinforced Concrete (FRC) is a composite material characterized by an enhanced post-cracking tensile residual strength, due to the capacity of fibres to bridge the crack faces by means of pull-out mechanism. Due to a better knowledge of FRC and the recent developments worldwide of guidelines for structural design, the fib Special Activity Group 5, who prepared the new fib Model Code, decided to introduce some sections on new materials and in particular on FRC structural design. At that time, working Groups TG 8.3 (“Fibre reinforced concrete”) and TG 8.6 (“Ultra high performance fibre reinforced concrete”) of fib prepared these sections of the new fib Model Code concerning FRC design rules for providing a guidance to engineers to properly and safely design FRC structural elements, both at serviceability and at ultimate limit states, based on the state-of-the-art knowledge. This bulletin was written with the aim to share the main framework used by the two

groups to introduce these two sections and to describe the many aspects already known, but not yet introduced in the Model Code. Even though the basic principles introduced in the two sections are mainly obtained from research on steel fibre reinforced concrete, the Model Code is open to every type of fibres, following a performance-based design approach. The bulletin represents a wide effort made by the people of the Task Group 4.1 and 4.2 to trace the knowledge on FRC and aims to be helpful for structural designers when using this new material in the practice.

*Concrete Structures for Oil and Gas Fields in Hostile Marine Environments* fib Fédération internationale du béton. 2008-12-01 Concrete offshore structures have been successfully delivered to the international oil and gas industry for more than 35 years. Some 50 major concrete platforms of different shapes and sizes, supporting large production and storage facilities, are currently operating in hostile marine environments worldwide and have excellent service records. After some years with little development activity, today there is a renewed interest in robust structures for the Arctic environment, for Liquefied Natural Gas (LNG) terminals and for special floating barges and vessels. Currently, concrete solutions are being considered for projects north and east of Russia, north of Norway and offshore Newfoundland, among others. Concrete is also in increasing demand in built up coastal areas for a variety of purposes such as harbour works, tunnels and bridges, cargo terminals, parking garages and sea front housing developments where durability and robustness are essential. The mandate of fib Task Group 1.5 was to gather the experience and know-how pertinent to the development, design and execution of offshore concrete structures, and to elaborate on the applicability of concrete structures for the Arctic environments. The findings of the Task Group are presented in fib Bulletin 50. The report is based on experience gained from the design, execution and performance of a number of offshore concrete structures around the world and in particular in

the North Sea. Ongoing inspections have shown excellent durability and structural performance, even in structures that have exceeded their design lives, in conditions often characterized by extreme wave loads, freezing conditions, hurricane force winds and seismic actions. This forms the background for discussing the applicability of concrete structures for the Arctic regions. Although to a large extent dedicated to oil- and gas- related structures, the report is also relevant to other marine applications where the same design principles, material selection criteria and construction methods apply. fib Bulletin 50 is not in itself a code, nor is it a textbook. Rather, extensive reference is made to proven and readily available design codes and construction guides, as well as relevant papers and proceedings and other fib publications.

*FRP Reinforcement in RC Structures* fib Fédération internationale du béton. 2007-01-01 fib Bulletin 40 deals mainly with the use of FRP bars as internal reinforcement for concrete structures. The background of the main physical and mechanical properties of FRP reinforcing bars is presented, with special emphasis on durability aspects. For each of the typical ultimate and serviceability limit states, the basic mechanical model is given, followed by different design models according to existing codes or design guidelines. Composite FRP materials are still relatively new in construction and most engineers are unfamiliar with their properties and characteristics. The second chapter of this bulletin therefore aims to provide practising engineers with the necessary background knowledge in this field, and also presents typical products currently available in the international market. The third chapter deals with the issue of durability and identifies the parameters that can lead to deterioration, which is necessary information when addressing design issues. A series of parameters is used to identify the allowable stress in the FRP after exposure for a specified period of time in a specific environment. The bulletin covers the issues of Ultimate Limit States (primarily

dealing with flexural design), Serviceability Limit States (dealing with deflections and cracking), Shear and Punching Shear and Bond and Tension Stiffening. It provides not only the state-of-the-art but also in many cases ideas for the next generation of design guidelines. The final chapter deals with the fundamental issue of design philosophy. The use of these new materials as concrete reinforcement has forced researchers to re-think many of the fundamental principles used until now in RC design. The bulletin ends with a discussion of a possible new framework for developing partial safety factors to ensure specific safety levels that will be flexible enough to cope with new materials.

### **Fib Bulletin 61** Book Review: Unveiling the Magic of Language

In a digital era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its ability to stir emotions, provoke thought, and instigate transformation is really remarkable. This extraordinary book, aptly titled "**Fib Bulletin 61**," published by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we will delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.



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