

Index

A

- Austria
 - bridge for pedestrians/cyclists, Lienz 143, 144
 - modular temporary bridge for high-speed rail lines 144–146
 - Wild bridge near Völkermarkt 141–143
- average bond stress 92
- axial force 70, 74, 77, 94
- axial strain 48
- axial tensile strength 33–36
- axial tensile test 29, 83, 105

B

- balcony 152–155
- bar-type shear reinforcement 79
- bauxite 23
- behaviour in compression 23, 24
- behaviour in tension 27
- bending/shear failure 78
- bending test 107
- Blastfurnace slag cement CEM III/A 12
- bond 24
- bond stress 14, 30, 31, 81, 92, 93, 97
- bridge 117–149
- brittle behaviour 6, 23, 27, 32, 44, 66, 69, 88, 97

C

- Canada 117
 - bridge for pedestrians/cyclists, Sherbrooke 117
 - Glenmore/Legsby footbridge, Calgary 117, 118
- capillary pore 61
- CDF test 62
- CEB-FIP Model Code 90 88, 89
- cement mortar 1
- centroid axis 98
- chloride ion diffusion depths 60
- coarse-grained 21, 23, 36
- CO₂ emission 3
- cohesion failure 107

- column 149–151
- compact reinforced composite 113
- compact reinforced concrete 2
- compression failure 88, 113
- compression test 23, 24, 32
- compression testing machine 32
- compressive strain 68, 69
- compressive strength 7, 27, 48, 50, 74, 79, 105
 - cylinder 23, 68
- compressive stress 25, 72
- concrete compressive strength 81
- connection 105
 - steel share strip for a shear-resistant connection 111
- connector
 - perfobond shear connector 108, 109
 - puzzle strip shear connector 110
- construction time 1
- corrosion rate, mortar 61
- corrosion-resistant
 - high-strength synthetic fibres 14
 - sulphuric acid 61
- cracking 95, 101
 - due to autogenous shrinkage 114
 - force 31, 99
 - formation 32, 51
 - patterns, of UHPC beams 83
 - spacing 90, 101
 - stresses 89, 99
 - temperature gradients 114
- cracking stress 100
- crack spacing 40, 92
- crack width 30, 31, 71, 73, 86, 89, 92, 93, 94
- creep 43, 44, 92, 109
- curing 17–18

D

- DAfStb guideline 22, 34
- deformation 36
 - behaviour 6
 - calculation 99, 102

- de-icing salt 62
- design, for bending and normal force 72
- design for shear tests 75
- Delft University of Technology 81–84
 - RWTH Aachen University 79–81
 - the University of Kassel 75–79
- design principles 65
- fibre distribution and fibre orientation, influence of 65
- design rules, for UHPC 3
- design value, of fibre efficiency 71
- DIF. *See* dynamic increase factor (DIF)
- dimensional tolerance 105
- dry joint 105
- Ductal[®] 2, 26
- ductile failure 81
- durability 1, 59–64
- aggressive media 59–63
 - ammonium nitrate solution 62
 - chloride ion diffusion depths 60
 - exposure classes, classification 63, 64
 - freeze-thaw and freezing/de-icing salt resistance 63
 - microstructure 59
 - pore radius 60
 - water absorption 62
- dynamic action 51–53
- dynamic increase factor (DIF) 51, 52
- dynamic tension load 52
- E**
- effective reinforcement ratio 97, 101
- elastic limit, for steel reinforcement 74
- embedment length 30
- energy consumption, of UHPC mixes 17
- EP adhesive 105, 108
- equilibrium condition 74, 96
- exposure class 64
- F**
- façade application
- to a building in Sedan 152
 - circular openings 152
 - to MuCEM building 151
 - police headquarters in Nantes, France 152, 153
- use of silicone 152
 - using white premix product 152
- fatigue 44–51, 88, 89, 110
- approximation of test results 46
 - behaviour of various concretes 45
 - fracture values
 - in Rendulic plane and stress–strain behaviour on 45
 - influence of hydrostatic pressure 45
 - S-N curve 46
 - test 48, 50, 51
 - triaxial testing machine 45
 - typical example of development of strains 47
- fibre bond strength 71
- fibre content 24, 81
- fibre efficiency 30, 31, 32, 65, 71, 90, 92, 94, 103
- fibre geometry 24
- influence behaviour of UHPC in tension 36
- fibre orientation 22, 24, 26, 65
- influence behaviour of UHPC in tension 36
 - influences flexural tensile strength and ductility 37
- fibre-reinforced concrete 31, 37, 39, 42, 53, 72, 90, 94
- fibre-reinforced UHPC
- beam without shear links, failure of 79
 - flexural tensile strength of 21
 - mixes 19
- fibres 26, 31, 51, 72, 79, 81
- activation phase 70, 73
 - and bar reinforcement, interaction 41, 42
 - cocktails 34, 53
 - distribution 65
 - high-strength steel 23, 24
 - pull-out phase 71
- fine-grained 23
- fire resistance 53
- fire tests, overview of results 54
- flexural tensile strength 32, 33, 34, 37, 55, 57, 79, 107
- flexural tensile stress 50, 51

flexural tensile test 32, 36, 105
 flow table test 18, 19
 fracture energy 28, 34, 37, 69
 France
 – Pont de la Chabotte, road bridge 120, 121
 – Pont du Diable footbridge 119, 120
 – Pont Pinel, road bridge 121–124
 – road bridge, Bourg-lès-Valence 118, 119
 – strengthening the Pont sur l’Huisne, Mans 124
 freeze-thaw cycle 63
 freezing/de-icing salt resistance 62
 friction coefficient 105

G

gap grading 9
 geometric reinforcement ratio 97, 100
 German Committee for Reinforced Concrete (DAfStB) 6
 German research programme 14, 20, 22, 61, 62, 79
 Germany
 – Bridge for pedestrians/cyclists over River Pleiße, Markkleeberg 140, 141
 – Bridges over River Nieste near Kassel 133, 134
 – Gärtnerplatz Bridge over River Fulda, Kassel 134–137
 – HSLV pilot project 137–140
 glued joints 105
 Goodman diagram 48
 grading optimization 8–11
 – admixtures, use of 6–7
 – ultrafine particles and residual pores 8
 grain size 2, 23, 48
 granulometric coefficient 7

H

hardened concrete
 – fibre orientation 22
 – mechanical properties 23
 heat-treated UHPC 63
 heat treatment 17–18, 27
 high-strength concrete 88

J

Japan
 – GSE Bridge, Tokyo Airport 126–128
 – Runway, Haneda Airport, Tokyo 157–160
 – Sakata-Mirai footbridge 124, 125
 – Tokyo Monorail, Haneda Airport line 128, 129
 Jean Bouin Stadium, Paris 160, 161
 joints
 – dry 105
 – glued 105, 107, 108
 – grouted 111–113
 – wet 108–111

L

linear elastic–ideal plastic curve 69
 load-carrying behaviour 30
 load-carrying capacity 3, 81, 86, 87
 load-carrying effect 29
 load–deflection curves
 – for beams with different types of reinforcement 79
 load–deformation behaviour 41, 81, 103
 load–slip relationship, for steel share strip 112
 load transfer length 90, 92
 localized deformation 29
 longitudinal reinforcement 76, 77, 83

M

macrocrack 53
 mass-based composition, of UHPC mixes 16
 mechanics-based model, for determining contribution of fibres 85
 microcracks 23
 microstructure 6–8, 12, 17
 mix composition 7, 15–17
 model for design, for bending and axial force 74
 modular ratio 92
 modulus of elasticity 23, 68, 79
 moment–curvature relationship 103
 multi-axial loading 48

multi-axial strength 87
 multi-axial stress 44

N

the Netherlands 147
 – Bridge made from UHPC for cyclists/
 pedestrians, Purmerend 148
 – erecting a UHPC panel for the Kaag
 Bridge 149
 – new bridge projects, the Dutch 147
 – reinforcement in UHPC bridge deck
 panel 148
 normal-strength concrete 24, 34, 35, 60,
 87, 88

P

packing density 2, 9, 10, 11, 59
 partially loaded area 88
 particle size 23, 36
 perfbond shear connector 108, 109
 pilot project 115
 ‘plastic’ behaviour 41
 Poisson’s ratio 24, 25
 polycarboxylate ether 11
 polypropylene (PP) 53
 polyvinyl alcohol (PVA) 14
 pore radius 60
 Portland cement 61
 post-cracking behaviour 28, 37
 post-cracking flexural tensile strength
 36
 post-cracking shrinkage strain 92
 post-cracking strength 31
 post-cracking tensile strength 83
 precast 134
 prestrain 103
 prestress, contribution to shear
 capacity 80
 prestressing force 82, 110
 prestressing steel 96, 97
 – effective reinforcement ratio 97
 – geometric reinforcement ratio 97
 pulverized fly ash (PFA) 13
 punching shear 84, 85
Puntke method 8, 11, 15
 puzzle strip shear connector 110, 111

Q

quartz powder 14

R

rapid chloride migration (RCM) test 59
 raw material
 – cement 12
 – ground granulated blast furnace slag 13
 – inert admixtures 14
 – reactive admixtures 12–13
 – silica fume 12–13
 – steel fibres 14–15
 – superplasticizer 14
 reactive powder concrete 2
 reinforcement
 – basic 78
 – minimum 97
 – ratio 101
 reinforcing bars 68, 114
 relaxation factor 92
 resistance 1
 restraint 105
 rheological properties 18
 rhombohedral packing 9
 RILEM method 55
 RILEM TC 162-TDF 21
 roofs designing 155
 – applications of UHPC 155
 – roof of precast UHPC segments at Villa
 Navarra, Le Muy, France 158
 – Shell roofs to Shawnessy Light Rail
 Transit Station, Calgary, Canada 155,
 156
 – UHPC canopy at entrance to ‘De
 Zonnestraal’ Hospital, Hilversum, The
 Netherlands 155, 156
 – UHPC roof shell at Millau viaduct,
 France 155, 156
 – UHPC roof to Villa Navarra 155, 157
 round robin test 20
 RPC adhesive 108

S

safety factor 68, 89
 scale effect 33
 scale factor 77

- secant modulus 39
- self-compacting concrete (SCC) 6, 18
- serviceability limit state 89
 - calculating deformations 99–103
 - limiting crack widths 89–97
 - minimum reinforcement 97–99
- shape coefficient for strain distribution 91
- shear behaviour 79, 82
- shear capacity 76, 77, 82, 83, 84, 105, 109, 110
- shear-compression test specimens 107, 108
- shear cracks 65, 79
- shear displacement 105
- shear force 65, 83, 105
 - model 76
- shear links 79, 82
- shear reinforcement 76, 79
- shear stress 105
- shear test 105, 110
- shrinkage 1, 42, 43, 92, 100
 - autogenous 42
 - drying 59
 - internal restraint caused by 100
- silica fume 1, 12, 13
- single-shaft compulsory mixer 15
- slab impact test 51
- slump-flow class 19
- slump-flow test 18
- slurry infiltrated fibre CONcrete (SIFCON) 1
- slurry infiltrated mat CONcrete (SIMCON) 1
- S-N curves 46, 49
- softening behaviour 69
- solidity 94
- solidity coefficient of stress distribution 39
- South Korea
 - Design for Jobal Bridge 132
 - KICT cable-stayed footbridge 131
 - Seonyu ‘Bridge of Peace,’ Seoul 129, 130
- spalling behaviour 55
- splitting tensile strength 36
- stair 152
- steel beams 2
- steel fibres 1, 2, 5, 14–15, 18, 19, 28
 - combination 56
- steel reinforcement 42, 100
- steel reinforcing bar 90
- steel strain 92
- steel stress 101
- stiffness 23
- strain hardening 28, 29, 74
- strength reduction 23, 53
- stress block 73, 92, 94
- stress–crack width behaviour 29
- stress–crack width diagram 42, 73
- stress–crack width relationship 29, 31, 33, 70, 71, 72, 85, 89, 92, 95
- stress–deflection diagram 36
- stress distribution 72, 73, 94
- stress–strain curve 24, 26, 69, 95, 101
 - for design 67, 68
 - for (fibre-reinforced) UHPC 100
- stress–strain diagram 24
 - for axial tension 28
 - compression 26, 69, 70
 - converting stress-crack width relationship into 39
- stress–strain line
 - for axial tension 39
- stress–strain relationship 26, 72
- structural length 40
- strut-and-tie models 85, 86
 - load-carrying capacity
 - of nodes 87
 - of struts 86, 87
 - of ties 87
- strut inclination 82
- struts in concrete
 - test to prove the formation 113
- sufficiently ductile 86
- sulphate resistance 12
- superplasticizer 5, 13, 14
- superposition
 - of matrix softening and fibre activation 30
- surface properties 24

- Switzerland 146, 147
- adding a layer of UHPC to a bridge deck 147
 - bridge repaired and widened with UHPC 147
 - conventional reinforced concrete, usage 147
 - waterproofed surfaces of bridge decks and bridge edge 146
- T**
- temperature-dependent compressive strength, of UHPC 56
- tensile/compressive strength ratio 88
- tensile forces 111, 114
- tensile strength 5, 17, 20–22, 28, 31, 32, 33, 35, 37, 70, 74, 76
- tensile stress 72, 91, 94, 115
- transferred by fibres at crack 98
- tensile test 21
- tension stiffening 101
- testing
- compressive/flexural tensile strengths 20–22
 - fresh concrete 18–20
 - machines 20
- thermal insulation 18, 154
- transfer length 40
- transverse tension 48
- U**
- UHPC layer 113, 114
- ultimate limit state 66, 67
- partial safety factors 67
 - safety concept 66
- uniaxial compression test 24
- uniaxial compressive stress 88
- V**
- volumetric water/solids ratio 8
- W**
- waterproofing qualities 114
- web 1, 75, 77, 79–82, 108, 123, 134
- X**
- X-ray computed tomography
- magnetic methods 22
 - photo-optical 22
- Y**
- yield point
- of reinforcement at a crack 73
- yield stress 82