

Spis treści

Preface	9
1. Mechanical terms and principles	13
1.1. Internal force and stress vectors in a beam – Cartesian coordinate system	13
1.2. Initial and actual configuration	15
1.3. Assumption on flat cross-sections	16
1.4. The principle of stiffness.....	16
1.5. Homogenous body.....	16
1.6. Hooke's model	17
1.7. Constitutive relation	17
1.8. Isotropy	17
1.9. Orthotropy.....	18
1.10. Anisotropy.....	19
1.11. Saint-Venant's principle of normal stress distribution equivalence.....	19
1.12. Fibre concept of a bending beam.....	21
1.13. Geometric characteristics of a cross-section	22
1.14. Homogenization – transforming to steel.....	23
1.15. Pure bending.....	25
1.16. Pure bending with stretching/compression.....	28
1.17. Delaminating force.....	30
2. Traffic loads on bridges. Elements of EN 1991-2	33
2.1. Road bridges.....	33
2.1.1. LM1	33
2.1.2. LM2	37
2.1.3. LM3	38
2.1.4. LM4	38
2.2. Railway bridges.....	38
2.2.1. LM71	38
2.2.2. SW/0 and SW/2	39
2.2.3. Unloaded train	39
2.2.4. HSLM	39
2.2.5. Dynamic factors Φ_2, Φ_3	40
3. Steel and concrete composite bridge girder	41
3.1. Basic cases of integration	41
3.2. Classical analysis of composite girder – Newmark's concept of integration.....	46
3.2.1. Step-by-step calculation of normal stresses due to pure bending by moment M.....	51
3.3. Distribution of bending moment M on the members of a composite girder	54
3.4. Normal force distribution in composite girder elements.....	58

3.5. Composite girder – shrinkage of the concrete slab	59
3.5.1. Initial and actual configuration appropriate for shrinkage	60
3.5.2. Strain distribution as a result of the flat cross-section assumption. Solution to the problem.....	61
3.5.3. Normal stresses distribution.....	63
3.6. Another approach to the shrinkage problem (force method).....	65
3.7. Cooling the concrete slab	66
3.8. Creep effect of the concrete slab	67
4. Shear connectors	70
4.1. Rigid connectors	70
4.2. Headed stud connectors	72
4.2.1. Ultimate state of a headed stud connector.....	74
4.3. VFT *	75
4.4. Perfobond rib shear connectors.....	76
4.5. Dowel connectors.....	77
4.5.1. Concluding comment.....	80
5. Methods and phases of composite bridge construction.....	82
5.1. Carrying deck deflection(s).....	83
5.2. Composite bridge construction methods.....	84
5.2.1. Method 1	85
5.2.2. Method 2	86
6. Zone above the pillar of the continuous carrying deck of a steel-concrete composite bridge	89
6.1. Espacenet.....	92
6.2. Author's proposal for the arrangement of the zone above the pillar	105
6.2.1. The new concept	106
7. Bending stiffness of a partially integrated composite concrete and steel girder	109
7.1. Fundamentals of a composite girder with partial interaction	110
7.2. The concept of the strain zero line shifting	115
8. J. Courbon's method	120
8.1. Discussion of other symmetric and antisymmetric decompositions	127
9. Dynamic amplifying factor – DAF	131
10. The influence of a strain rate on the understanding of dynamical processes	134
10.1 Hopkinson-Kolsky bar	138
10.2. Reason for significant increases in concrete strength with an increasing strain rate.....	143
10.2.1. The limits of the Stefan model.....	144
11. Rheology and rheological models.....	145
11.1. Elementary models.....	146
11.2. Two parameter models.....	150
11.3. Three parameter models	153

11.4. Generalisations of the Voigt and Maxwell models	154
11.5. Boltzmann superposition	156
11.6. Rheological models in the study of fresh concrete	157
12. Laplace transform in viscoelasticity problems	158
12.1. Derivative transform	159
12.2. Laplace transform of an integral	159
12.3. Retransformation by virtue of the residuum theorem	160
13. Viscoelasticity – applications of the Laplace transform	163
13.1. Solution of the Voigt model	163
13.2. Viscoelasticity – creep function	166
13.3. Viscoelasticity – the relaxation function and its connection with the creep function	167
13.4. Compliance and the relaxation moduli of creep	168
13.5. Fractal derivative	168
14. Bridge aesthetics – an alternative approach	173
Bibliography	183
Summaries in Polish and English	192