

CONTENTS

PREFACE	iii
NOTATIONS	v
Notations for Sections 1 to 4	v
Notations for Section 5	vi
1. INTRODUCTION AND GENERAL	1
1.1 Types of composite flexural members	1
1.1.1 Definitions	2
1.2 Development of composite interaction in flexural members	3
1.2.1 Generalized Steiner rule	3
1.2.2 Transformed section and its cross-sectional properties	5
1.2.3 Composite stiffness parameter	6
1.2.4 Effects of incomplete or partial interaction	7
1.3 Identification of shear connections	8
1.4 Role and tasks of shear connections	9
2. MECHANICAL MODELS FOR SHEAR CONNECTIONS	11
2.1 Shear flow in continuous connections	11

CONTENTS

2.1.1 Connection shear flow in different types of composite cross-section	13
2.2 General load-slip properties of shear connections	13
2.2.1 Mechanical connections	14
2.2.2 Mixed connections	15
2.2.3 Bond connections	16
2.3 Definitions for full and partial interaction - serviceability behaviour in elastic range of stresses	16
2.3.1 End slip in beams of two components without shear connection	18
2.3.2 End slip in beams of two components with shear connection	20
2.3.3 Connection flexibility parameter r_δ	24
2.4 Classification of shear connections as based on their load-slip properties	29
2.4.1 Ductile and non-ductile connections	30
2.4.2 Classification of shear connections into plastic and softening ones	31
2.4.3 General analysis of unzipping connection behaviour	32
2.4.4 An important case of unzipping connections	34
2.5 Various states of ductile shear connections	39
2.5.1 Partial connection theory of ordinary composite beams to EN 1994-1-1	40
2.5.2 Partial connection theory for shallow floor beams	46
2.5.3 Differences between partial connection behaviour of ordinary composite beams and shallow floor beams	49
2.6 Minimum slip capacity of ductile shear connectors	53
2.6.1 Methods of evaluating the end slip in ULS	54
3. TYPICAL END SLIPS PREDICTED BY THE FLEXIBILITY PARAMETER	65

3.1 Flexibility effects in serviceability conditions	65
3.1.1 Connection modulus in case of stud shear connectors	65
3.1.2 Ordinary composite beams with composite slabs with profiled steel sheeting	67
3.1.3 Shallow floor composite beams	68
3.2 End slips in the ultimate limit state by different approaches	69
3.2.1 Connection modulus in plastic shear connection of SF-beams	70
3.2.2 Numerical evaluations for ordinary composite beams to EN 1994-1-1	72
3.2.3 Numerical evaluations for shallow floor composite beams	76
3.2.4 Composite beams with shear connection of high flexibility	78
3.2.5 Compatibility of the shear connector behaviour in push tests and beam tests	79
3.2.6 Properties of various shear connectors	82
4. COMPOSITE SLABS WITH PROFILED STEEL SHEETING	83
4.1 Definition of the shear span	83
4.2 Ductility vs. non-ductility definition of the shear connection	83
4.3 Methods of design for the load-bearing capacity of composite slabs	84
4.3.1 Partial shear connection method for composite slabs with ductile connection	85
4.3.2 The m - k method for composite slabs with any type of shear connection	86
4.3.3 Requirements for the slab tests	86
4.3.4 Effects that influence the longitudinal shear behaviour	87
4.3.5 Interpretation of test results into bond strength	89
4.4 Deep decking composite slabs	90

CONTENTS

5. QUASI-STATIC AND FATIGUE BEHAVIOUR	91
5.1 Factors affecting the fatigue life	93
5.1.1 Effects of moving loads causing fatigue	93
5.1.2 Degradation of connector resistance due to cyclic loading	95
5.1.3 Employment of push tests for observations on cyclic behaviour of studs	96
5.2 German research	97
5.2.1 Main results of cyclic push-tests	98
5.2.2 Changes in the shear stiffness of stud connectors due to cyclic loading	101
5.2.3 Beam tests and FEM analyses	102
5.2.4 Fatigue in hogging regions of continuous beams	105
5.3 Low cycle fatigue	106
5.4 Conclusions on fatigue behaviour	108
REFERENCES TO SECTIONS 1 TO 4	111
REFERENCES TO SECTION 5	116