Table of Contents

1	Int	roduction and Aim	9
2	Hig	gh-Performance Steels in the United States	11
	2.1	Introduction	11
	2.2	HPS Research and Development Program	12
		2.2.1 HPS70W	13
		2.2.2 HPS 50W	14
		2.2.3 HPS 100W2.2.4 Fatigue and Fracture Properties	14 15
		2.2.5 Wettability	17
		2.2.6 Weathering Characteristic	18
	2.3	Design and Construction Specifications	19
	2.4		20
		2.4.1 First HPS 70W Bridge	20
		2.4.2 The Nebraska HPS Two-Box Girder System2.4.3 HPS Cost Study	21 21
		2.4.4 Tennessee Experience	22
		2.4.5 Pennsylvania Experience	23
		2.4.6 New York State Thruway Authority Experience	24
	2.5	HPS Fabrication Experience	25
	2.6		25
		2.6.1 Availability 2.6.2 Cost	25 25
	2.7		
		Producers and Industry Organizations	26
	2.8	Websites	27
	2.9	Continuing Research	27
		Closing Remarks	28
		References	29
		Acknowledgements	30
	2.13	Appendices	31
3	Fat	igue Research on High-Performance Steels in Canada	45
	3.1	Introduction	45
	3.2	HPS Research at the University of Alberta	46
		3.2.1 Introduction	46
		3.2.2 Experimental Program Overview3.2.3 Chemical Composition, Fracture Toughness,	46
		and Tensile Properties	47

		3.2.4 FR Series Fatigue Tests	48
		3.2.5 FL Series Fatigue Tests	49
		3.2.6 Fatigue Crack Growth Rate Tests	50
		3.2.7 Fatigue Life Prediction	51
		3.2.8 Observations from University of Alberta Research	52
	3.3	HPS Research at the Queen's University	53
	3.4	First Canadian HPS Demonstration Bridge	54
	3.5	Summary and Conclusions	54
	3.6	References	54
4	Hi	gh-Performance Steels in Japan	57
	4.1	Bridge High-Performance Steel (BHS) Concept	57
	4.2	New High-Performance Steel Material for Bridges in Japan	58
		4.2.1 Application of Conventional High-Performance Steel	
		Materials for Bridges in the Past	58
		4.2.2 Proposal of New High-Performance Steel Material for Bridge	
		and Required Properties	59
		4.2.3 Summary	65
	4.3	Manufacturing Technology and Confirmed Performance of BHS	65
		4.3.1 Progress in Manufacturing Technology that supports BHS	65
		4.3.2 Confirmed Performance of BHS 500	67
		4.3.3 Design of BHS 700	72
		4.3.4 Welding Materials for BHS	72
		4.3.5 Summary	73
	4.4	Advanced Weathering Steels	73
		4.4.1 Performance and Current Application Status	
		of Advanced Weathering Steels	73
		4.4.2 Weathering Resistance Index	80
		4.4.3 Summary	83
	4.5	Improvement of Fatigue Strength	84
		4.5.1 Target for Improvement of Fatigue Strength	84
		4.5.2 Mechanism of Low-Temperature Transformation	
		Welding Material and Basic Characteristics	85
		4.5.3 Study based on Fatigue Tests	88
		4.5.4 Summary	92
	4.6	Examples and Applications	92
		4.6.1 BHS Projects in the Future	92
		4.6.2 Current Status of Application of Nickel Containing	
		Advanced Weathering Steels	93
	4.7	References	96

Hig	gh-Performance Steels in Europe	99
5.1	Production Processes, Mechanical and Chemical Properties,	
	Fabrication Properties	99
	5.1.1 Introduction	99
	5.1.2 Production Processes for High-Strength Steel	100
	5.1.3 Products and Properties	103
	5.1.4 Fabrication Properties	106
	5.1.5 Conclusions	110
5.2	Toughness Requirements in Structural Applications	110
	5.2.1 General	110
	5.2.2 Background of Fracture Mechanics Safety Assessment	
	to Avoid Brittle Fracture	112
	5.2.3 Yield-to-Tensile Strength Ratio Requirement	117
5.3		120
	5.3.1 Introduction	120
	5.3.2 Eurocode 3 Format for Resistance to Instability	121
	5.3.3 Resistance to Flexural Buckling	122
	5.3.4 Resistance to Local Buckling	125
	5.3.5 Resistance to Shear Buckling	127
	5.3.6 Discussion and Conclusions	128
5.4	Improving the Fatigue Resistance	128
	5.4.1 Introduction	128
	5.4.2 Detailing	130
	5.4.3 Welding Procedures and Workmanship	130
	5.4.4 Post-Weld Improvement Methods	131
	5.4.5 Conclusions	136
5.5	Examples and Applications	136
	5.5.1 Fast Bridge 48 Military Bridge, Sweden	137
	5.5.2 Hybrid Girder Bridge, Mittadalen, Sweden	138
	5.5.3 Road Bridge over the River Rhine at Dusseldorf-Ilverich,	
	Germany	139
	5.5.4 Composite Bridge near Ingolstadt, Germany	140
	5.5.5 Roof Truss of the Sony Centre in Berlin, Germany	141
	5.5.6 Millaut Viaduct, France	142
	5.5.7 Verrand Viaduct, Italy	143
5.6	References	144

S	ammary and Conclusions	147
6.1	General	147
6.2	HPS Developments, Research and Applications	147
	6.2.1 HPS in the USA	147
	6.2.2 HPS in Canada	147
	6.2.3 HPS in Japan	148
	6.2.4 HPS in Europe	148
6.3	High-Performance Steel Properties	149
	6.3.1 Mechanical Properties	149
	6.3.2 Chemical Properties	150
	6.3.3 Weldability and Fabrication	150
	6.3.4 Fatigue	151
	6.3.5 Weathering Characteristics	151
6.4	Applications of HPS	152
6.5	Concluding Remarks	152