

Contents

1	INTRODUCTION	1
2	STATE OF THE ART	3
2.1	Deformation mechanisms in high-Mn steels.....	3
2.2	Fundamentals of hydrogen embrittlement.....	5
2.2.1	Hydrogen solubility and diffusion	5
2.2.2	Hydrogen trapping	7
2.2.3	Hydrogen damage and associated mechanisms.....	8
2.3	Manifestations of hydrogen embrittlement in high-Mn steels.....	9
2.4	Influencing factors on hydrogen embrittlement of high-Mn steels	10
2.4.1	Microstructural effect	11
2.4.2	Mechanical effect.....	14
2.4.3	Environmental effect	15
2.5	Effect of cutting processes on mechanical properties of steels	15
2.5.1	Introduction to cutting methods.....	16
2.5.2	Cutting effect on mechanical properties	19
3	EXPERIMENTAL PROCEDURE	22
3.1	Materials.....	22
3.2	Initial microstructure and tensile properties	22
3.3	Parameter of cutting methods	23
3.4	Roughness measurement	24
3.5	Analysis of residual stresses and micro deformations	24
3.6	Hardness test	25
3.7	Hydrogen charging and slow strain rate test.....	26
4	RESULTS.....	29
4.1	Initial microstructure and tensile properties of as-delivered materials	29
4.2	Microstructure at cut-edges.....	33
4.3	Microstructure at cutting-affected zones	37
4.4	Roughness at cut-edges	44
4.5	Residual stresses and micro deformations	45
4.6	Micro-hardness profiles	48
4.7	Hydrogen content measurement	49
4.8	Slow strain rate test (SSRT) and fracture surface	50
4.9	Edge cracking after slow strain rate test (SSRT).....	76
5	DISCUSSION	80
5.1	Effects of cutting methods on cut-edge properties	80

Table of Contents

5.1.1	General appearances at cut-edges and cutting-affected zones	80
5.1.2	Mechanical properties at cut-edges and cutting-affected zones	81
5.1.3	Comparison with other high-strength steels	82
5.2	Effects of cut-edge properties on hydrogen embrittlement behavior	83
5.2.1	SSRT without hydrogen charging	83
5.2.2	Hydrogen charging	83
5.2.3	SSRT with hydrogen charging	84
5.2.4	Comparison with other high-strength steels	85
5.3	Fractography	86
5.3.1	Without hydrogen influence	86
5.3.2	With hydrogen influence	87
5.3.3	Precrack effect from blanking	89
5.3.4	Edge cracking	92
5.4	Suggestions for further investigations	92
6	CONCLUSIONS	94
7	REFERENCES	96