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STRESS-STRAIN CURVES of MILD CARBON STEELS for DECOMMISSIONING WASTES TRANSPORTAION CONTAINER

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1. Introduction

The development of wastage package, transportation and disposal containers for decommissioning wastes of nuclear power plant has been undergoing in Korea. While the conceptual design of a container is still in progress, the most promising material for metal container is a mild carbon steels such as ASTM A36 [1] and KS D 3568 [2].

Mild carbon steel is the primary material used for beams, frames, girders, and construction elements such as angles and plates. Behavior and modeling of mild and reinforcing carbon steel has been studied by Clinton Rex for the American Institute of Steel Construction [3]. In this study, two grades of mild steel, ASTM A36 and SRT275 (previously SPSR400 per KS D 3568) have been investigated in tensile properties and the corresponding tensile properties and the stress-strain behaviors were compared with data from literature [3]. Tensile tests were conducted at the Center for Research Facilities of Hanbat National University.

2. Tensile Tests

110 mm long plate tension test specimens were used for tensile tests as shown in Fig. 1 and ASTM E8 standard [4] was applied in this test. Table 1 shows the chemical composition of two grades of mild steels and it is noted that chemical composition of SRT275 is similar to that of SS275 (previously SS400 per KS D 3503 [5]). To investigate the effect of rolling direction, two different specimens were machined along rolling direction and transverse directions, respectively.

Tensile tests were performed at room temperature and two different loading rates were applied; 0.001/sec and 0.01/sec. Gage length of a specimen is 25mm and loading rate of 1.5mm/min is corresponding to 0.001/sec.

Fig. 2 shows the tensile test rig (capacity of 10 tons) which is located at the Center for Research Facility of Hanbat National University.

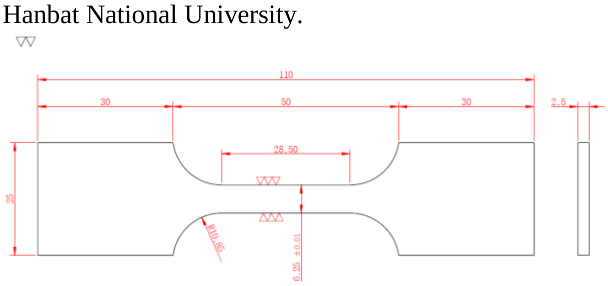

Fig. 1 Tensile test specimen (mm)

Table 1. Chemical compositions of the A36 and SRT275 steels (wt.%)

	C	Si	Mn	S	P
A36	0.14	0.01	0.45	0.008	0.01
SRT275	0.18	0.01	0.46	0.001	0.007

Fig. 2 Tensile test facility

Table 2 shows the resultant tensile properties of two mild steels (A36 and SRT275) along the longitudinal direction and transverse directions, respectively. Young’s modulus, yield strength (YS), tensile strength (UTS), tensile elongation (UTE), and rupture elongation are compared between two materials. It is noted that ASME SA-36 (Specification for Carbon Structural Steel), which corresponds to ASTM A36, indicates tensile requirements of 400-550 MPa of tensile strength, 250 MPa of yield strength, and 20-23% of elongations. Current test results of mild carbon steels show the equal or larger physical properties than those of ASME specification [6].

The effect of loading rate between 0.001/sec and 0.01/sec is negligible and the results for 0.001/sec are reviewed primarily. The impact of rolling direction is significant and detailed discussion is presented. To verify reproducibility of test results, at least three specimens were used for each condition of test.

Table 2. Tensile properties of the A36 and SRT275 steels (loading rate 0.001/sec)

	Young's modulus (MPa)	Yield strength (MPa)	Tensile strength (MPa)	Elongation (%, UTE)	Elongation (%, Rupture)
A36(L)	201	362	482	11	23
A36(T)	215	395	495	13	29
SRT275(L)	191	306	425	20	39
SRT275(T)	196	242	415	22	39

Fig. 3 shows the stress-strain behavior of SRT275 (SS400) along longitudinal direction (L) and transverse direction (T), respectively. Overall behavior (UTS and elongations) is similar even though the yield strength in transverse direction is smaller.

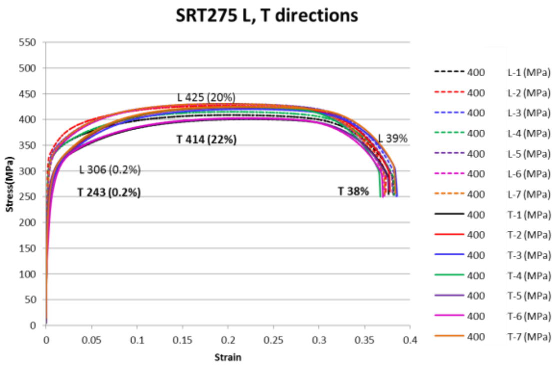

Fig. 3 Stress-strain curves of SRT275

Fig. 4 shows the stress-strain behavior of A36 along longitudinal direction and transverse direction, respectively. Tensile strength and tensile elongation are similar but the yield behavior and rupture elongation are quite different. One can see the upper and lower yield points in transverse direction but there is no such behavior observed in longitudinal direction. Rupture elongation in transverse direction is larger than that of longitudinal direction.

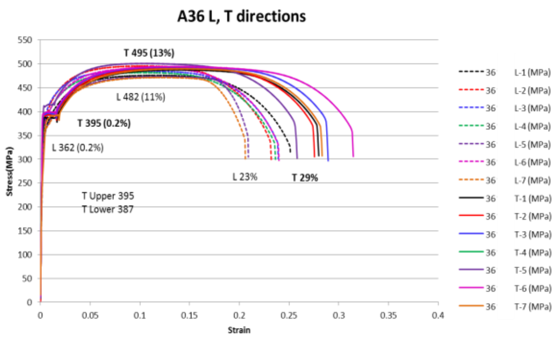

Fig. 4 Stress-strain curves of A36

Fig. 5 shows the comparison of stress-strain behavior between A36 test results and data of Rex [3]. Yield strength and tensile strength of A36 are 30% and 20% larger than those of Rex, respectively, while the upper and lower yield points are observed in both A36 transverse result and data of Rex.

Fig. 6 shows the comparison of stress-strain behavior between SRT275 test results and data of Rex [3]. Though the upper and lower yield points were not observed in SRT results, overall tensile behavior is similar among results.

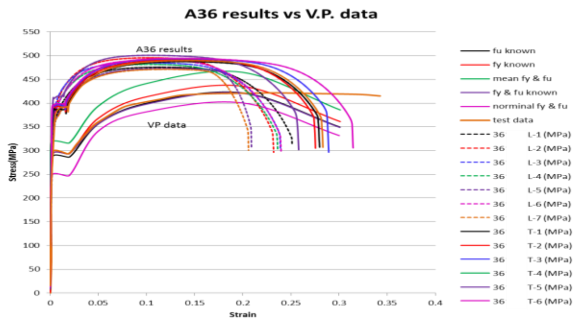

Fig. 5 Comparison of tensile behavior between A16 and literature (VP data) [3]

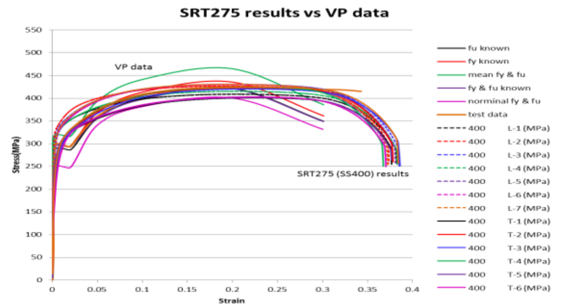

Fig. 6 Comparison of tensile behavior between SRP275 and literature (VP data) [3]

3. Results and Discussion

In this study, the stress-strain curves for potential carbon steels, such as ASTM A36 and SRT275, were developed and compared with the data of Rex. Both test results were well compared to the data of Rex. And the upper and lower yield points were observed in A36 tests in transverse direction while they are not observed in SRT275 tests. It seems that the properties of carbon steel square of SRT275 are different from those of a plate due to the processing hardening. It is suggested to perform tensile tests of the SS275 plate to supplement the stress-strain curves for decommissioning waste transportation containers.

Acknowledgement

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