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Welded Built-Up Columns

MATERIAL PROPERTIES OF STRUCTURAL CARBON

AND HIGH STRENGTH STEELS

by

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MATERIAL PROPERTIES OF STRUCTURAL CARBON AND

HIGH STRENGTH STEELS

This is a summary of tests on the material properties of A7, A36, A242, A440 and A441 steels. The results include the static yield stress, modulus of elasticity, strain hardening modulus, and strains at first attainment of yield stress and at the onset of strain hardening. These properties are shown in Fig. 1.

The tests were conducted in connection with various projects listed below:

Project 220A. Residual Stress & Compressive Properties of Steel

Project 249. Residual Stresses & Welded Columns

Project 269. Residual Stresses & A242 Steel Columns

Project 288. Large Bolted Connections

Project 296. Hollow Structural Tubing

Project 297. Plastic Design in High Strength Steels

All the coupons were tested in a 120,000 lb screw type universal testing machine with an electronically operated load indicator and automatic recorder. The properties were determined directly from the recorded load-strain diagram. Elongation was measured over an 8" gage length after fracture. The tests were conducted according to ASTM specifications.

The results of the tests are given below.

Property	A7*	A36	A242	A440	A441
σ_{ys} (ksi)	34.1	38.1	54.5	43.4	54.8
E (ksi)	29,600	29,500	30,900	30,450	29,400
E_{st} (ksi)	700	728	734	786	442
ϵ_y (in/in)	0.0013	0.00123	0.00167	0.00143	0.00188
ϵ_{st} (in/in)	0.014	0.0106	0.0166	0.0104	0.0206
ϵ_{st}/ϵ_y	12.0	8.4	10.3	7.3	11.1
Elongation(%)		24.4	26.3	27.2	21.5

Range of variation of these properties are given in the Appendix

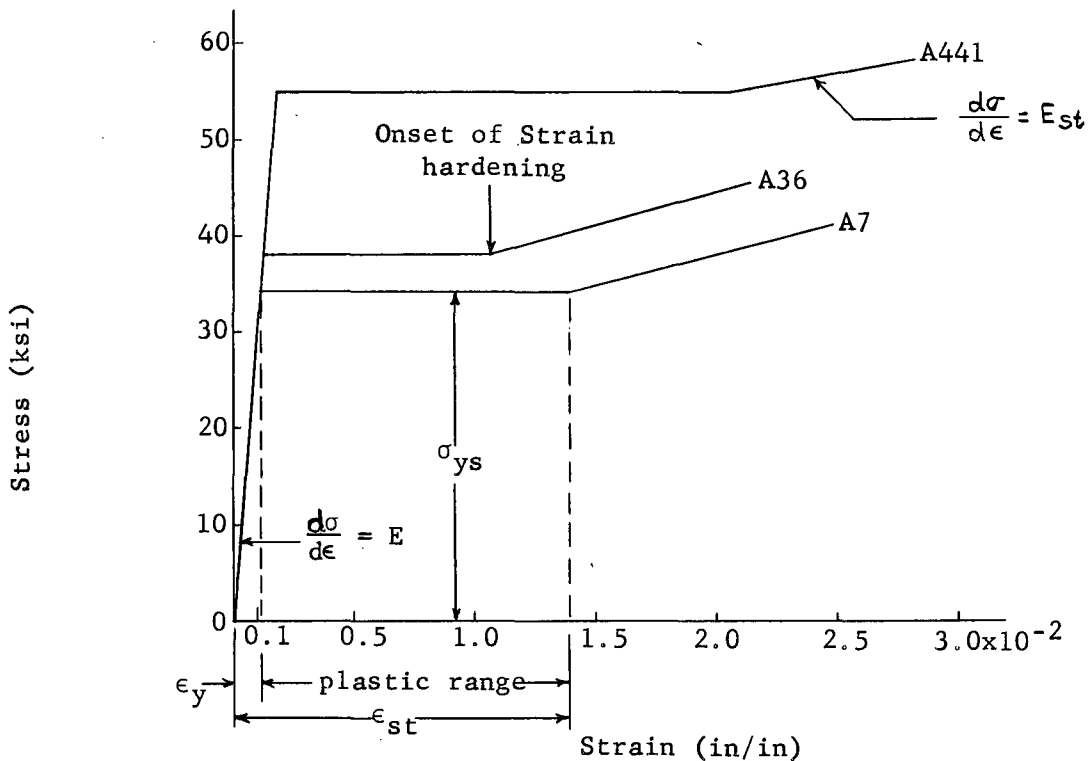* The values for this steel are taken from the Proc. AISC Nat'l Engr. Conf., 1956

Fig. 1 Typical Stress-Strain Diagram

GLOSSARY OF TERMS

Yield Stress Level (σ_y) - The average stress during actual yielding in the plastic range. It remains fairly constant for structural steel provided the strain rate remains constant.

Static Yield Stress (σ_{ys}) - The yield stress level at zero strain rate. (This is obtained by stopping the movement of crossheads in the plastic range.)

Modulus of Elasticity (E) - The ratio of stress to corresponding strain below the proportional limit.

Strain Hardening Modulus (E_{st}) - The ratio of stress to corresponding strain in the strain hardening region.

Elongation - The increase in gage length of a tension test specimen, usually expressed as percentage of the original gage length.

Appendix

A36

Property	No. of Tests	Mean	Maximum	Minimum
σ_{ys} (ksi)	80	38.1	44.6	34.5
E (ksi)	78	29,500	35,700	26,100
E_{st} (ksi)	13	728	1,160	525
ϵ_y (in/in)	13	0.00123	0.00130	0.00112
ϵ_{st} (in/in)	13	0.0106	0.0182	0.0060
ϵ_{st}/ϵ_y	13	8.4	15.7	4.1
% Elongation	77	24.4	30.5	17.2

A242

Property	No. of Tests	Mean	Maximum	Minimum
σ_{ys}	15	53.5	55.8	50.4
E (ksi)	14	30,900	32,800	28,900
E_s (ksi)	4	734	990	500
ϵ_y (in/in)	9	0.00167	0.00187	0.00155
ϵ_{st} (in/in)	4	0.0166	0.0180	0.0148
ϵ_{st}/ϵ_y	4	10.3	10.5	10.0
% Elongation	15	26.3	33.5	20.5

A440

Property	No. of Tests	Average	Maximum	Minimum
σ_{ys} (ksi)	2 40	43.4 42.9	44.3	41.4
E (ksi)	2	30,450		
E_{st} (ksi)	1	786	797	775
ϵ_y (in/in)	2	0.00143	0.00145	0.00140
ϵ_{st} (in/in)	2	0.01040	0.01055	0.01025
ϵ_{st}/ϵ_y		7.3	-	-
% Elongation	2 40	27.2 28.0	28.1 30.6	26.2 26.2

A441

Property	No. of Tests	Average	Maximum	Minimum
σ_{ys} (ksi)	15	54.8	66.5	49.3
E (ksi)	14	29,400	31,700	26,000
E_{st} (ksi)	15	442	683	297
ϵ_y (in/in)	15	0.00188	0.00220	0.00170
ϵ_{st} (in/in)	14	0.02060	0.02800	0.01538
ϵ_{st}/ϵ_y	14	11.1	15.4	7.0
% Elongation	11	21.5	25.8	15.6