

Table E–2. Values of the tensile strength, TS , of A 36, CSA G40.21-44W, and A 572.

Steel	TS (ksi)	TS (MPa)	ϵ_{TS}	e_{TS}
A 36	64.5	444	0.204	0.226
CSA G40.21-44W	70.6	487	0.160	0.173
A 572	74.3	520	0.160	0.173

ϵ_{TS} true strain at the value of the tensile strength, TS .

e_{TS} engineering strain at the value of the tensile strength, TS .

E.2.2 ANSYS Stress-strain Models

The analysis used the ANSYS multilinear isotropic hardening model (MISO). This model defines piecewise-linear stress-strain curves at fixed temperatures. The origin is not included, and the slope of the first segment between the implied (0,0) and the first point, which is the yield strength, must equal the elastic modulus at the appropriate temperature. Each steel model, shown in Tables E–3, E–4, and E–5, consisted of ten stress-strain pairs, plus the implied (0,0) at specific temperatures: (20, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850) °C. The creep models consist of lines that define the temperature and stress-strain pairs, for example

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TBTEMP, 20
TBPT, , 1.2370e-03, 36.8
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The TBTEMP line defines the temperature as 20 °C. The TBPT line defines the strain-stress pair in which the strain is 1.2370×10^{-3} and the stress is 36.8 ksi. Figures E–4, E–5, and E–6 show the shapes of the stress-strain curves generated by the ANSYS models of Tables E–3, E–4, and E–5.

E.3 METHOD FOR CREATING HIGH-TEMPERATURE CREEP CURVES

E.3.1 Background

The WTC investigation developed a methodology for estimating the creep properties of untested steels based on creep models of existing steels. We evaluated several different scaling methods. Scaling the applied stress by the ratio of the tensile strength of the reference steel to that of the unknown steel produced the best agreement. We drew this conclusion by predicting, using the fitted creep models of Williams-Leir (1983), the behavior of each of five literature steels from a sixth literature steel, for all possible permutations of those six steels. Although tensile strength scaling produced the best agreement, in many cases the agreement was not very good. Frequently the predicted strain differed from the actual by more than a factor of ten. Differences of this magnitude correspond to temperature offsets of around 35 °C or stress offsets of 17 MPa. Not surprisingly, the agreement was best when the correction was small, and within a class, e.g., steels specified with $YS = 36$ ksi or $YS = 50$ ksi. Because no steel relevant to the creep modeling was recovered from WTC7, it is impossible to create more accurate models.