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Tim Stauffer

Paul McEntee

Use of Mill Certificates to Establish Material Properties in Testing of Cold-Formed Steel Components

Tim Stauffer, S.E.[1] and Paul McEntee, S.E.[2]

Abstract

Testing is often used to establish the available strength of cold-formed steel components. The evaluation of this test data requires adjustment based on the material properties of the tested components to account for values that exceed the minimum specified values. Currently, it is required that this adjustment be based on samples taken from the tested specimen or the flat sheet used to form the test specimen. However, in many cases it is not practical to obtain these samples. Instead, it is desired to permit an alternate that allows the use of mechanical properties reported by the steel supplier. The purpose of this study was to provide data for use in developing such an alternate approach.

Introduction & Discussion

In cold-formed steel construction, it is often necessary or desirable to perform testing of components. In the United States, the evaluation of this test data and determination of design strength and allowable strength is typically done in accordance with Chapter F of AISI *North American Specification for the Design of Cold-Formed Steel Structural Members* (AISI S100). These provisions include requirements to adjust test results based on the material properties of the tested components to account for base metal thickness, yield stress, and tensile strength that exceed the minimum specified values. In the current (2007) edition of AISI S100 this adjustment is required to be based on samples taken from the tested specimen or the flat sheet used to form the test specimen.

In many cases it is not practical to obtain samples as described. The test specimen may be too small or have a geometry that makes it difficult to obtain test coupons. Also, when testing is conducted it is common to take specimens from manufacturer inventory. In this case the steel sheet used to form the component is typically no longer available. It is impractical to require either that all steel used in manufacturing be sampled in case testing is performed at a later date, or that components be manufactured every time testing is conducted in order to make steel available for sampling. As a result, an alternative approach that permits the use of mechanical properties reported by the steel supplier is desired.

The purpose of this study was to compile and present data on the yield stress and tensile strength of steel determined by both mill certificates and test coupons for the same steel material. It is intended that this data be used as a basis to develop an alternative that allows the use of mill certificates when adjusting test results to account for material properties of the tested component.

[1] R&D Engineer, Simpson Strong-Tie Company Inc.
[2] Manager of Engineering, R&D, Simpson Strong-Tie Company Inc.

Approach and Scope of Study

The study compiled data collected by one manufacturer over a period of several years. In the study, the yield stress, F_y, and tensile strength, F_u, was obtained for a sampling of steel material used in manufacturing. Material property data was obtained from mill certificates provided by the steel supplier, as well as from tension tests performed on specimens taken from the steel sheet. Tensile tests were performed in accordance with ASTM A370. Data is included for three different specified material grades (Grade 33, Grade 40, and Grade 50), as well as material thicknesses ranging from 27 mil (22 ga.) to 229 mil (3 ga.)

Results

Table 1 summarizes the material property data and presents a comparison between the material properties for each sample. Comparisons are presented as a material property ratio, which is calculated as the value based on coupon tests divided by the value from mill certificates. Figures 1 through 3 also present the data graphically to aid in identifying trends.

Conclusions

The purpose of this study was to provide data for use by others, so no recommendations are provided. Also, only general qualitative conclusions and observations are presented. Noteworthy observations of the data presented include the following:

- Yield stress and tensile strength obtained from coupon tests typically exceed those obtained from mill certificates.
- The correlation between values obtained from mill certificates and coupon tests is higher for tensile strength than for yield stress.
- The results appear to be independent of material thickness.
- The correlation between values obtained from mill certificates and coupon tests for both yield stress and tensile strength increases as the specified minimum value increases.
- The correlation between values obtained from mill certificates and coupon tests for both yield stress and tensile strength increases as the value from mill certificates increases.

Table 1: Summary of Yield Stress and Tensile Strength Data

Minimum Thickness (mils)	Reference Gauge Desig.	ASTM Desig.	Material Properties (ksi)						Material Property Ratio	
			Specified Minimum		Mill Certificate		Coupon Tests			
			Yield Stress, $F_{y\text{-}spec}$	Tensile Strength, $F_{u\text{-}spec}$	Yield Stress, $F_{y\text{-}mc}$	Tensile Strength, $F_{u\text{-}mc}$	Yield Stress, $F_{y\text{-}cpn}$	Tensile Strength, $F_{u\text{-}cpn}$	$\frac{F_{y\text{-}cpn}}{F_{y\text{-}mc}}$	$\frac{F_{u\text{-}cpn}}{F_{u\text{-}mc}}$
27	22	A653	33.0	45.0	46.1	55.9	48.4	52.9	1.05	0.95
33	20	A653	33.0	45.0	45.7	53.7	51.7	56.2	1.13	1.05
33	20	A653	33.0	45.0	35.8	52.5	41.3	56.8	1.15	1.08
43	18	A653	33.0	45.0	42.2	52.7	49.4	54.5	1.17	1.03
43	18	A653	33.0	45.0	41.6	50.3	51.0	55.5	1.23	1.10
43	18	A653	33.0	45.0	38.8	51.0	47.0	54.7	1.21	1.07
43	18	A653	33.0	45.0	38.8	51.0	47.1	55.8	1.21	1.09
54	16	A653	33.0	45.0	37.7	49.8	43.5	51.4	1.15	1.03
54	16	A653	40.0	55.0	44.7	55.1	49.4	55.7	1.11	1.01
54	16	A653	40.0	55.0	40.0	51.5	46.8	53.3	1.17	1.03
54	16	A653	50.0	65.0	50.0	63.9	47.9	60.7	0.96	0.95
68	14	A653	33.0	45.0	38.2	50.8	43.0	53.5	1.13	1.05
68	14	A653	33.0	45.0	48.6	59.9	52.0	61.0	1.07	1.02
97	12	A653	33.0	45.0	39.0	52.2	49.8	57.5	1.28	1.10
97	12	A653	40.0	55.0	50.0	65.5	44.4	62.3	0.89	0.95
118	10	A653	33.0	45.0	35.0	51.0	46.0	52.8	1.31	1.04
118	10	A653	33.0	45.0	35.0	51.0	42.3	53.3	1.21	1.05
171	7	A653	33.0	52.0	54.5	64.0	54.7	65.5	1.00	1.02
171	7	A653	33.0	52.0	35.7	48.9	39.9	51.5	1.12	1.05
171	7	A653	50.0	65.0	54.9	75.0	58.3	79.8	1.06	1.06
229	3	A1011	33.0	52.0	38.4	57.3	45.9	61.8	1.20	1.08
								Average=	1.13	1.04
								Minimum=	0.89	0.95
								Maximum=	1.31	1.10
								Standard Deviation=	0.10	0.05
								Coefficient of Variation=	0.09	0.04

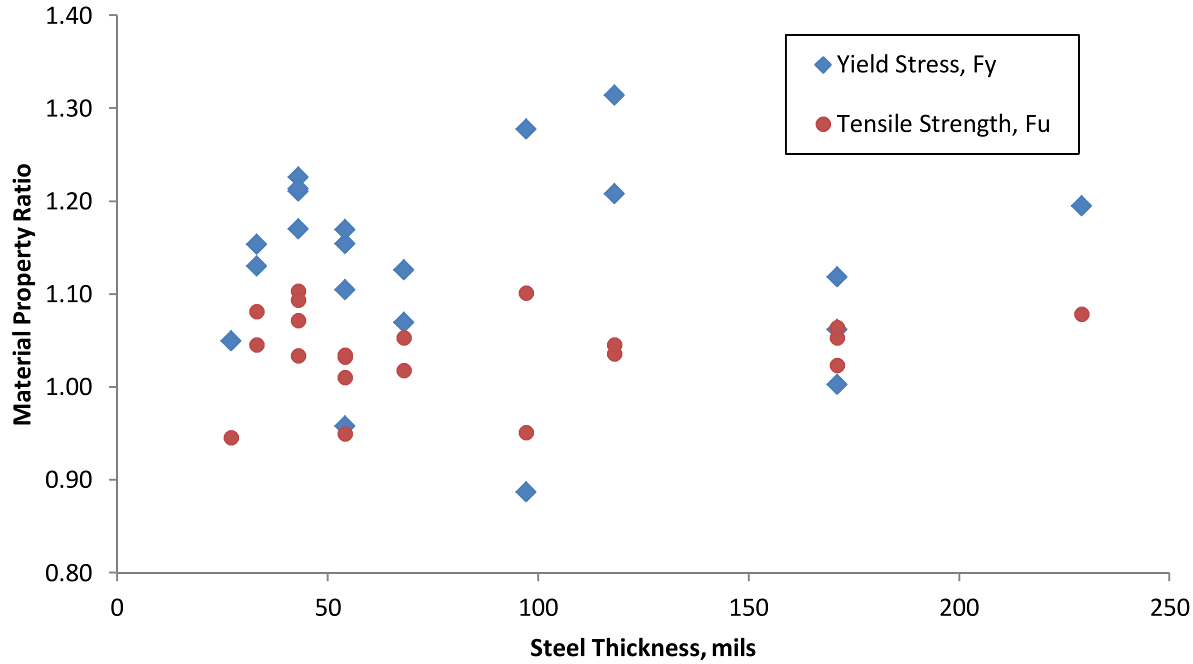

Figure 1: Material Property Ratio vs. Steel Thickness

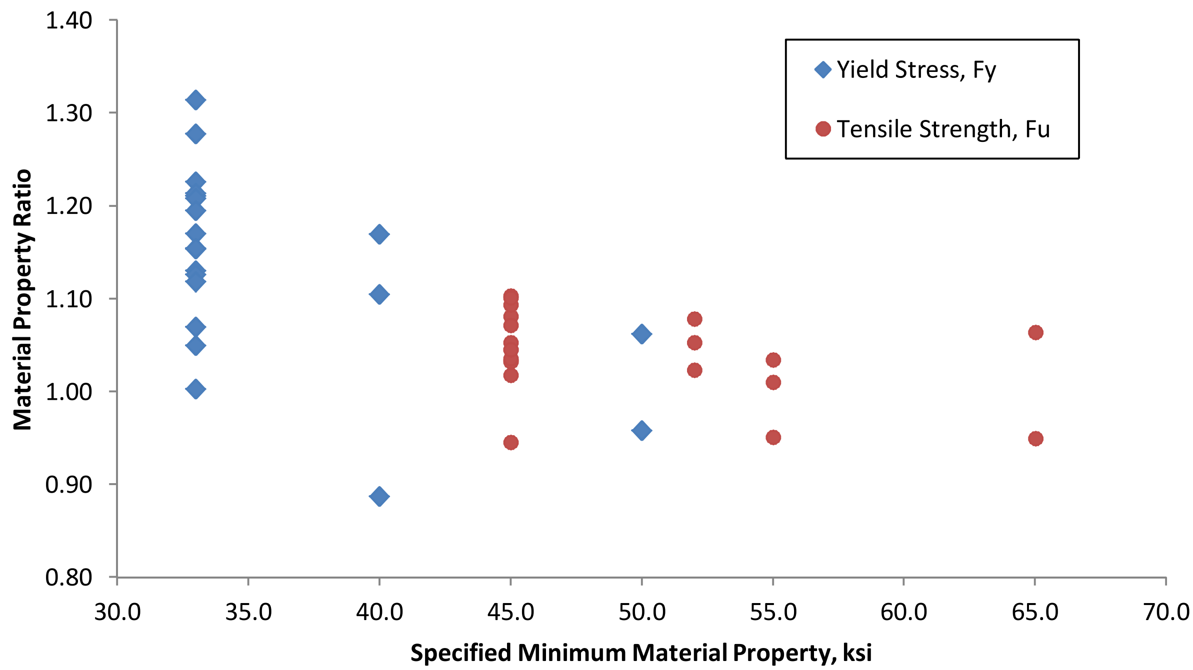

Figure 2: Material Property Ratio vs. Specified Minimum

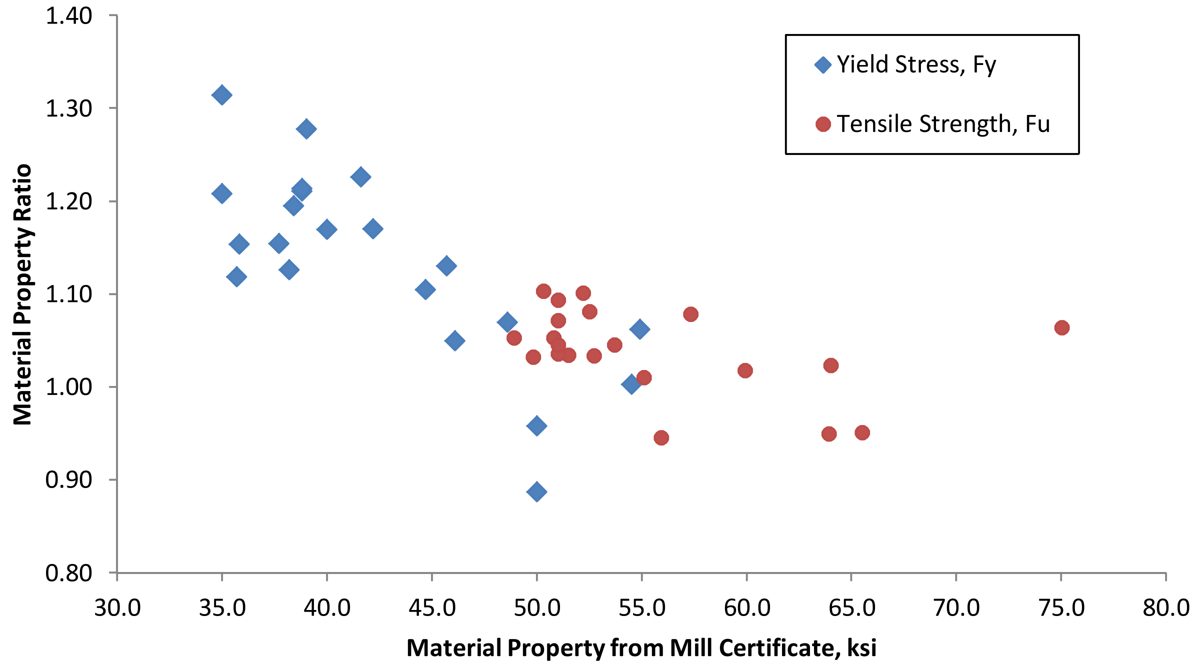

Figure 3: Material Property Ratio vs. Value from Mill Certificate