SECTION 7

SAFETY FACTORS

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Safety factors are defined as the ratio of the ultimate stress to the working or allowable stress.

$$\text{SAFETY FACTOR (S.F.)} = \frac{\text{ULTIMATE STRESS (U.S.)}}{\text{ALLOWABLE STRESS (A.S.)}}$$

$$\text{therefore, A.S.} = \frac{\text{U.S.}}{\text{S.F.}}$$

Safety factors compensate for:

- allowable tolerances of the part
- uncertainty of the anticipated loading (magnitude, type or placement)
- assumptions in methods of analysis
- fabrication tolerances (squareness of cuts, normal tolerances, etc.)

In Section 3 - **PROPERTIES OF EXTREN®**, Strongwell lists the **minimum** ultimate values for stresses obtained from coupon or full section testing. Typical property values are generally 20% -25% higher than those listed. Even though these are minimum ultimate stresses, these values **should not** be utilized for design purposes before dividing them by the appropriate safety factor.

The safety factors used in the various design tables were chosen to prevent first deformation of the part. First deformation is defined as the first visible deformation including local flange or web buckling, twisting, crushing, etc. The recommended safety factors used for design are:

	RECOMMENDED SAFETY FACTORS ①
Flexural members, beams	2.5 ②
Compression members, columns	3.0 ②
Shear	3.0
Connections	4.0
Modulus of Elasticity	1.0 ③
Shear Modulus	1.0 ③

NOTES:

① The safety factors given are for **static load conditions only**. Safety factors for impact loads and dynamic loads are typically **two times** the static load safety factor, see *Mechanics of Materials*, Reference 7. Long term service loads which result in creep deformations will require higher safety factors to insure satisfactory performance. For creep effects, see *Structural Plastics Design Manual,* Reference 2.

② Strongwell has developed empirical equations which calculate the allowable stresses for **EXTREN®** when used as compression members (columns) and as flexural members (beams). These equations, used to generate the allowable load tables found in this design manual, are the result of full section testing. This testing more accurately reflects the performance of the column or beam and should be used instead of coupon properties. The designer should use the allowable load found in the appropriate table, which includes a safety factor of 3.0 for columns and 2.5 for beams.

It must be noted that these equations are applicable only for **EXTREN®** and are a function of the proprietary resins and glass placement in the **EXTREN®** composite plus the size and shape of the part. The use of these empirical equations for pultruded products other than **EXTREN®** is not recommended and could result in a structural failure.

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③ The moduli reported in Section 3 - **PROPERTIES OF EXTREN®** is the minimum value obtained from tests of full size sections of **EXTREN®** structural shapes which allows a safety factor of 1.0. **CAUTION:** If deflections are critical and unexpected temperature variations occur, problems may arise due to loss of stiffness. Refer to "Temperature Effects" in Section 3 for safety factors for the moduli at elevated temperatures.

These recommended safety factors, as well as the safety factors used in the generation of allowable load tables for beams and columns, are not the only safety factors that may be used in design. The designer may choose to adjust the safety factors based on particular applications and considerations including margin of safety, costs, confidence of loads or materials, etc.

Ultimately, the final selection of a safety factor is the designer's privilege as well as responsibility.