Structural Design

An installed cable tray system functions as a beam under a uniformly distributed load. The four basic beam configurations found in cable installations are simple, continuous, cantilever and fixed. Each is attached to the cable tray support in a different way.

Continuous Beam

Cable tray sections forming spans constitute a continuous beam configuration, the most common found in cable tray installations. This configuration exhibits characteristics of the simple beam and the fixed beam. For example, with loads applied to all spans at the same time, the ends spans function like simple beams, while the counterbalancing loads on either side of a support function like a fixed beam. As the number of spans increases, the continuous beam behaves increasingly like a fixed beam, and the maximum deflection continues to decrease. As this occurs, the system's load carrying capability increases.

Simple Beam

A straight section of cable tray supported at both ends but not fastened functions as a simple beam. Under a load, the tray will exhibit deflection. The load carrying capacity of a cable tray unit should be based on simple beam loading, since this type of loading occurs at run ends, offsets, etc., in any tray system. The NEMA/CSA Load Test is a simple beam, uniformly distributed load test, used primarily because it is easy to test and represents the worst case beam condition compared to continuous or fixed configurations. The only criterion for NEMA/CSA acceptance is the ability to support 150% of the rated load.

Fixed Beam

Like the cantilever beam, a fixed beam applies more to the cable tray supports than the tray itself, because both ends of a fixed beam are firmly attached to the supports. The rigid attachment prevents movement and increases load bearing ability.

Cantilever Beam

A cantilever beam has more to do with the cable tray supports than the tray. Attaching one end of a beam to a support while the other end remains unsupported, as when wall mounting a bracket, creates a cantilever beam configuration. Obviously, with one end unsupported, the load rating of a cantilever beam is significantly less than that of a simple beam.

Design Loadings

Basic cable trays are designed on the basis of maximum allowable stress for a certain section and material. The allowable cable load varies with the span, type and width of the tray.

Splicing

Since the need for a continuous system requires that siderails be spliced, splice plates must be both strong and easy to install. T&B Aluminum Snap-In Splice Plate allows hands free installation of hardware for easier assembly. If practical, splices in a continuous span cable tray system should be installed at points of minimum stress. Unspliced straight sections should be used on all simple spans and on end spans of continuous span runs. Straight section lengths should be equal to or greater than the span length to ensure not more than one splice between supports.

Examples of splicing configurations are shown on page 17.

Basic Design Stresses

Allowable working stresses are the basis for all structural design. Since they must be of such magnitude as to assure the safety of the structure against failure, their selection is a matter of prime importance. In practice, a basic design stress is determined by dividing the strength of the material by a factor of safety. The determining factors in establishing a set of basic design stresses for a structure are therefore the mechanical properties of the materials and suitable factors of safety. Yield strength and ultimate strength are the mechanical properties most commonly considered to govern design. Values for these properties are readily obtainable. In determining the factor of safety, the designer must usually be guided by current practice—the "standard specifications" adopted by various technical societies and associations—and his or her own judgment and experience.

Factors of safety

Since a low value for the factor of safety results in economy of material, the designer seeks to establish a value as low as is practical, based on sound engineering judgment and experience. In making the determination, consideration of the following factors are highly important:

The accuracy with which the loads to represent service conditions are selected and assumed. If there is much doubt concerning these loads, the basic design stress will have to be more conservative than under conditions where the loads are known with considerable accuracy.

The accuracy with which the stresses in the members of a structure are calculated. Many approximations are used in structural design to estimate stress distribution. The choice of a factor of safety should be consistent with how accurate the analysis is. The more precise the method, the greater the allowable unit stress may be.

The significance of the structure being designed. The designer must keep in mind the relative importance of the structure and appraise the possibility of its failure causing significant property damage or loss of life. In this respect, the significance of the design will govern the choice of a factor of safety to a considerable extent.
The factors of safety used in designing most common types of structures are an outgrowth of the experience gained from many applications and tests—even failures. The trend in recent years has been to reduce the factors of safety in line with improved quality of material and increasing knowledge of stress distribution. Further reductions may be made in the future as greater accuracy in determinations becomes possible and practicable.

Application of design stresses to cable tray systems

A cable tray manufacturer must design standard products to accommodate the great variations encountered in applications. The factors affecting the selection of a suitable basic design stress necessarily result in more conservative stresses than might otherwise be required.

An engineer, who is in a position to determine specific stress requirements with a far greater degree of accuracy, may consider that the manufacturer's basic design stresses are too conservative for a particular project. Using individual experience and judgment, he or she would establish a new set of basic design stresses, selecting those safety factors that would result in a cable tray system best suited to meet the projected service conditions. With these stresses, the engineer can easily calculate an increase or decrease in the manufacturer's loading data, since the load is always in direct proportion to the stress.

The factors of safety used in determining maximum allowable stresses are as follows:

- Aluminum Alloys

  a. For tension: the lower of 1/3 the minimum ultimate strength or 1/2 the minimum yield strength in tension.
  b. For compression: the lower of 1/3 the minimum ultimate strength or 2/5 the minimum yield strength in compression.
  c. For shear: the lower of 1/3 the minimum ultimate strength or 1/2 the minimum yield strength in shear.

- For Hot Rolled Steels

  a. For tension: the lower of 1/2 the minimum ultimate strength or the minimum yield point in tension times .61.
  b. For compression: the lower of 1/2 the minimum ultimate strength or the minimum yield point in compression times .61.
  c. For shear: maximum stress not to exceed a value of 2/3 the basic design stress for tension.

Design Efficiency

A tray designed to perform its required function with the minimum weight (which facilitates installation) requires the material to be used in the most effective manner. The design requirements of siderails are different from those of rungs or ventilated bottom; fabricated tray allows the designer to use different shapes and thicknesses of metal to the best advantage. The strength of the siderail and rungs is increased by the proper use of metal in the high strength heat-treated aluminum or continuously rolled cold-worked steel sections.