No structure is exactly level, straight and true. No product is identically reproduced. Fortunately, such perfection is not absolutely necessary.

Tolerance for purposes of this article is defined as the allowable variation or permissible deviation in dimensions, quantity or quality. Variation can usually be in either of two directions and so can be regarded as positive or negative (plus or minus).

Tolerances are a means to establish permissible variation in dimension, location, appearance and performance; giving both the designer, the contractor and the manufacturer parameters within which the work is to be performed.

Tolerances are the means by which the designer conveys to the contractor, the performance expectations upon which the design is based, or the use of the project required. As such, specified tolerances should reflect design assumptions and project needs; being neither overly restrictive nor lenient.

Necessity rather than desirability should be the basis of selecting tolerances. The immediate reason for specifying tolerances is to establish the ease of construction without the necessity of later modifying parts to fit together. The long range reason is to ensure that the structure will perform as needed.

The required degree of accuracy of performance depends on the interrelationship of a number of factors:

- **Structural Strength and Function Requirements.** The structure must be safe and strong reflecting the design assumptions, and accurate enough in size and shape to do the job for which it was built.
- **Aesthetics.** The structure must satisfy the appearance needs or wishes of the owner and designer. Designers often specify unrealistic tolerances without questioning the lack of realism in the data they have access to.
- **Economic Feasibility.** The specified degree of accuracy has a direct impact on the cost of production and for the construction method. For example, the tolerances achievable with precast vs. cast-in-place concrete are likely to be quite different. If the specifier arbitrarily establishes a tolerance, he may be unknowingly prescribing the construction method to be used and possibly thereby increasing the cost. In general, the higher degree of accuracy required, the higher the cost of obtaining it.
- **Relationship of All Components.** The required degree of accuracy of individual parts can be influenced by adjacent units and materials, joint and connection details, and the possibility of the accumulation of tolerances in critical dimensions. A simple example is to try to install a 5/8” inside diameter nut on a 1/2” diameter bolt or install three 4” wide panels with a 1/2” joint width requirement between panels between columns exactly 12’ apart. Compare the accuracy of using a 12” ruler and moving it along a line to measure 24’ as opposed to using a 50’ tape measure to obtain the same 24 ft. mark.
- **Construction Techniques.** The feasible tolerance depends on the available craftsmanship, technology and the materials involved. Skill results from training and familiarity with a product or process and speed results from practice, but the correct sequence of installation steps, adequate visibility and sufficient time are also requirements to achieve a given tolerance.
- **Properties of Materials.** The difficulties encountered in predetermining the end result of such phenomena as shrinkage or deflection should be
"If your work does not comply with these tolerances, you are solely responsible and the fix, if one is possible, will come out of your pocket."

recognized in establishing tolerances.

Compatibility. Designers should use finish and architectural details which are compatible with the type or anticipated method of construction and such details should be compatible with the tolerances which are achievable with the actual construction method.

Job Conditions. Unique job situations and conditions must be considered. The designer must specify and clearly identify those items which require either closer or more lenient tolerances as the needs of the project dictate. Climatic variations, for example, are but one of many conditions that can create unique situations on a job site.

Measurement. In building construction, mutually agreed upon control points and bench marks must be provided by reference points for measurements, to establish the degree of accuracy of items produced. Such control points and bench marks must be maintained in an undisturbed condition until final completion and acceptance of the project.

The individual contractor must contend with two basic types of tolerances, which can be identified as “theirs” and “Ours.” The wall and ceiling contractor will not have control over the accuracy of the structural components or assemblies to which he must install, attach or adhere his product or assembly.

Because the wall and ceiling contractor does have both the responsibility for and control over the “ours” type of work, he must be familiar with and be able to recognize conditions done by others that may prevent him from meeting his own responsibilities.

For the prudent contractor, the time to recognize “unacceptable” conditions is before his own work begins. Many specifications appear to be based on the assumption that if you cover it, you have accepted it as suitable.

Some industries have established “published tolerances” which are capable of being measured to determine if they have been achieved. Other industries, including the wall and ceiling industry, have tended to rely on so-called “industry standards.” In this author’s opinion, these standards exist only in the minds of the individuals who have been placed in the position of making a judgement in a specific situation.

In the absence of a set of specific numbers to be guided by, the “expert” is forced to rely on his own experience and understanding of the industry to make a judgement.

It has been said that “beauty is in the eye of the beholder.” If the beholder is an owner or his representative, and is also the holder of the checkbook and there are no published concensus tolerances to judge by, it becomes a sometimes impossible task to convince the owner that what has been done is acceptable by some unpublished standard and, therefore, you should be paid in full immediately.

Another reason in favor of published tolerances, both “theirs” and “ours” is where you are able to determine that “theirs” is out of tolerance before you start, you have an opportunity to delay your start until “they”
fix it, or to charge for the extra labor and material required for you to fix it.

There is, of course, a disadvantage to published tolerances that are “our” responsibility. If your work does not comply with these tolerances, you are solely responsible and the fix, if one is possible, will come out of your pocket.

Almost everything involved in the construction process can be subjected to a tolerance requirement. The following is certainly not an all-inclusive list:

- Length
- Width
- Height
- Thickness
- Weight (Mass, Density)
- Strength (Compressive, Flexible, Racking, Bond, Impact, Hardness, etc.)
- Deterioration With Age
- Contraction
- Expansion
- Water/Air Permeability
- Sound/Fire/Thermal Resistance
- Finished Appearance Texture
- Color
- Color Fastness
- Chemical Resistance

...and so on...

Tolerances have been established for many manufactured products or components. Such tolerances are an attempt at standardization. They are generally based on the capability of the manufacturer to establish quality control over the raw materials received, the processing equipment employed and the skill and efficiency of his labor force. Efforts to improve qualities of a product will be determined by “is it possible,” “is it necessary,” “what will it cost.”

Even with manufactured components there can be cumulative tolerance difficulties. As an example, the manufacturer of cold-rolled steel sheet is allowed a “mill tolerance” of plus or minus from a basic thickness. Let’s assume 5%. The fabricator of diamond mesh expanded metal lath is permitted a weight variation of plus or minus 10%. The possible cumulative weight variation permitted is now 15%. The material specification allows a width tolerance of plus or minus 3/16 inch of 27 inches. Since such lath is manufactured by stretching a slitted sheet, the width difference can further alter the weight from the specified weight of 2.5 or 3.0 pounds per square foot. The permissible span of metal lath between supports is based on the specified weight.

The tolerances established for fitting components together and the conditions under which such assembly occurs are usually more difficult to monitor or enforce for a number of obvious reasons.

Illumination requirements will vary with the degree of accuracy required. Installation and inspection should be done under the same amount of illumination. Limiting ranges of temperatures are invariably required for products containing or mixed with water.

The uniformity of texture and color of hand applied materials is subjected to variations of temperature, wind, humidity, sunlight, dust, surface area materials and workmanship.