Chapter 10

Introduction to "Beams with Cross-Sections"

In Part II beams and bars were introduced as one-dimensional structural elements because in that way the theories for them could be established in a systematic way. At that point we were not concerned with whether the beams and bars had cross-sections—we just assumed that we knew the constitutive relations between the generalized stresses and the generalized strains. For a Bernoulli-Euler beam they are the generalized stresses N and M and the generalized strains ε and κ, while for a Timoshenko beam the generalized stresses are N, V and M and the generalized strains are ε, φ and κ . So, we might say that we considered beams and bars "without cross-sections." On the other hand, when we wish to analyze a "real" structure we need a way to determine the constitutive behavior of the structural elements. For linearly elastic beams this entails setting up formulas for EA, GA_e and EI for Timoshenko beams and EA and EI for Bernoulli-Euler beams. For perfectly plastic or elastic-plastic beams and bars other constitutive parameters enter the picture.

Determination of constitutive relations for beams

Since the majority of structural analyses assumes linear elasticity this will be our first topic here. It is, however, good to bear in mind that no material behaves linearly elastic and that it may be necessary to account for other effects such as plasticity or time-dependent behavior.[10.1]

Here, only linear elasticity

[10.1] In general, the more complicated and expensive the structure the more pertinent it is to use a more realistic material model. In designing a beam in a carport one can make do with linear elasticity, but in the case of a big concrete bridge that does not suffice.

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