DESIGN GUIDELINES:
DG03. STRUCTURAL ANALYSIS

TECBEAM

3.1 Introduction

Extensive testing has confirmed that the structural behaviour of composite Tecbeam joists can be modelled using the standard principles of structural mechanics, including linear elastic response up to the yield point of the steel web. The structural engineer can be confident in using standard beam design formulas when designing a Tecbeam floor.

Tecbeam joists are certified to comply with the requirements of the Building Code of Australia.

Shear deformation in the composite 'I' beam is a significant component of the total deflection, particularly in shorter spans; this is due to shear action in the pressed metal web (stiffening ribs, holes, etc). Any analysis involving stiffness, e.g. deflection or bending moment distribution, should include the shear rigidity parameter (GA).

A simplified method of analysis is proposed which can be time saving when doing manual calculations, and can also be used with commonly available software programs that only calculate the flexural deflection and ignore shear deformation.

The composite beam section properties I_x and Z_x are derived from the transformed section which is based on the short duration modulus of elasticity E, multiplied by 1.05. Values given in AS1720.1 include a 5% reduction for the effect of shear deformation in solid timber beams; this does not apply to Tecbeam joists because of the steel web. The shear deformation component is covered by the shear rigidity parameter (GA); the values in the Section Properties table are based on test results and the theoretical transformed second moment of area.

Tests for long-term creep indicate the deformation duration factor j_2 is close to 1.3. Due to timber variability, a value of $j_2 = 1.4$ has been recommended.

3.2 Analysis Methods

Following are two methods of design/analysis where beam stiffness is involved:

1. Simplified: combined flexural and shear rigidity parameters into an equivalent EI_e parameter. This value varies with the span; it is suitable for manual calculations and in beam analysis software programs.
2. Conventional: separate flexural and shear rigidity parameters; EI_x & GA. It is suitable for use in software programs that include a separate calculation for web shear deformation, and where the design is done from first principles.

Method 1 Simplified

The accuracy of this method is similar to Method 2. In beam deflection formulas web shear rigidity is often omitted, this is easily corrected by substituting 'I_x' with an equivalent stiffness value I_e which varies with the span. Curves of I_e vs Span are included in the Design Guidelines. The value I_e can be used in beam deflection formulas, for single or continuous spans, and also in cantilevers.

eg

single span, uniform load $$y = \frac{5}{384}\frac{wL^4}{EI_e}$$

or equivalent load method $$y = \frac{cML^2}{9.6EI_e}$$

where

c = 1.0 uniform load
c = 0.8 centre point load
c = 0.6 support moment

Ref. Steel Designers Handbook, Gorenc Tinyou -Table B15

M = max bending moment for each sub-load
E = 1.05xE, MGP10 E = 10,500 MPa
MGP12 E = 13,300 MPa
LVL13 E = 13,860 MPa

Method 2 Conventional

Calculate the flexural and shear deformation components separately using the tabulated section properties EI and GA,

eg

equivalent load method $$y = M_1\left(\frac{c_1L^2}{9.6EI} + \frac{1}{GA}\right) + M_2\left(\frac{c_2L^2}{9.6EI} + \frac{1}{GA}\right) + \ldots$$

where

$M_1, M_2 \ldots =$ max. bending moment for each sub-load
$c_1, c_2 \ldots =$ modification factor for each sub-load, see Method 1

NOTES

1. When using a software design/analysis program, check if web shear is included.
   This will be confirmed if the beam parameter input includes web details, ie thickness and depth or area (A), and modulus of rigidity (G). If this is the case two options are available:
   a) use the parameters given in the Section Properties table for EI and GA, or
   b) use Ie and input the shear web area as a large number so its effect is not included twice.
2. For cantilever spans, select Ie based on a span which is twice the cantilever span.
3. Load sharing using secondary (crossing) beams or strongbacks can often eliminate separate beams.
   Where the secondary beam passes through several joists a suggested distribution, based on analysis of several different cases, is given in Section 2.5; these distribution values will give the maximum shear, bending and deflection in the secondary beam.
   Note
   (1) Using the grid system modification factor g_{42}, AS 1720.1 Appendix E8.2, will result in a significant under-estimation of the loads in the secondary beam and a much higher proportion of the load in the joist under the point load. The secondary beam will be significantly under-designed. (The factor g_{42} is relevant to particle board flooring with numerous butt joints).
   (2) Where a supporting external wall is within 1.5 m of the end joist, it is recommended to extend the strongback to the wall; this can eliminate a separate beam or reduce the number of joists required under a parallel external wall. Load distribution will be similar to the diagram in Section 2.5