masterSERIES

Technical Note

Title: Timber Deflections to EN 1995-1-1:2004+A1_2008

Date: 15/03/2022

Versions: All

Program: MasterKey Timber Design – Integrated & Stand-Alone

Description

The Eurocode timber design EN 1995-1-1 2.2.3(3) states the final deflection of a timber member should be calculated for the quasi-permanent serviceability loading case to EN 1990 6.5.3(2) c.

$$G_K + \sum_i \psi_{2,i} Q_{k,i} \qquad \text{(eq1)}$$

However, the instantaneous part of the load should be determined from the Characteristic load case EN 1990 6.5.3(2) a

$$G_K + Q_{k,1} + \sum_{i>1} \psi_{0,i} Q_{k,i} \qquad \text{(eq2)}$$

Where Gk is permanent action. Qk,1 and Qk,i are leading and accompanying variable action.

Whilst the code is a little unclear this means that the final deflection is arrived at as

$$u_{fin} = u_{qp,mf} + (u_{ch,m} - u_{qm,m}) \qquad \text{(eq3)}$$

Where

$u_{qp,mf}$ = deflection quasi-permanent case using $E_{mean,fin}$

$u_{ch,m}$ = deflection characteristic case using E_{mean}

$u_{qp,m}$ = deflection quasi-permanent case using E_{mean}

$$E_{mean,fin} = \frac{E_{mean}}{(1+k_{def})} \qquad \text{(eq4)}$$

Where k_{def} is a factor dependent on the service class, which accounts for creep effects. For solid timber this is 0.6. 0.8 and 2 for service class 1,2 and 3 respectively.

EN 1995-1-1 2.2.3(5) provides a simplified method for (eq3) for members with the same creep behavior, which is the majority of cases.

$$u_{fin} = u_{inst,G}\left(1 + k_{def}\right) + u_{inst,Q1}(1 + \psi_{2,1}k_{def}) + \sum_i u_{inst,Q,i}(\psi_{0,i} + \psi_{2,i}k_{def}) \qquad \text{(eq5)}$$

Where

u_{isnt} are the instantaneous unfactored deflections calculated using E_{mean}

G is the permanent action

Q_1 is the leading variable action

Q_i is the accompanying variable action

MasterKey Timber Implementation

Stand-alone timber beam design

In the stand-alone timber beam design, the simplified method is used as the deflection is calculated for each load component using empirical deflection equations.

Integrated Timber Design –MasterFrame

In these cases, the deflection is determined from the structural analysis serviceability load cases. There is currently no direct method in the software to calculate deflection according to (eq3) or (eq5). However, by adjusting load group factors the effect of (eq5) can be produced.

1. In both MasterFrame the option to 'Use E.mean.fin' should be checked, which will apply the kdef to the Emean, which will be used in the structural analysis. This setting can be found in Properties> Member Sections Materials (set on a per-member basis, however can be changed more generally with Global editing mode).
2. Serviceability loading cases set up with appropriate factors, i.e., as per (eq5).

Take the following example of a beam with the following loads

Load Type	MasterFrame Load Group
Gk – Permanent	D1
Qk,1 – Leading variable load	L1
Qk,i – Accompanying variable load	L2

Since the E.mean.fin is already used the L1, and L2 load factor would then need to be as follows.

MasterFrame Load Group	Required Deflection Case Load Factor	Example load factor for Service class 1, kdef = 0.6 and ψ_2 = 0.3 and ψ_0 = 0.7
D1	1.0	1.0
L1	$(1 + \psi_{2,1} * k_{def})/(1 + k_{def})$	0.738
L2	$(\psi_0 + \psi_{2,i} * k_{def})/(1 + k_{def})$	0.55

Please note that the MasterKey Timber integrated design will examine all serviceability load cases analysed and use the deflection of the most critical loading case. Therefore, you should ensure that other types of service case are not included in the analysis. Loading cases can be suspended rather than completely deleted.