Checklists for Model Validation and Results Verification

1. Model Validation

The model needs to be validated against the objectives of the analysis. for example overestimating deflection may not be conservative in a dynamic analysis.

- **Linear elasticity** General: for prediction of internal forces the lower bound theorem conditions should be satisfied (i.e. internal forces in equilibrium with applied load, no stress/moment greater than yield, adequate ductility). This may be satisfied by sizing of members to a code of practice.
  Steel - stress < f_y; Concrete - for short term deformation $f_c < f_{cu}/3$, for long term deformation - not valid

- **Bending theory, shear deformation**

Span/depth ratio	Situation
>10	Bending theory good, shear deformation negligible
<10, >5	Shear deformation less insignificant but normally neglected
< 5	Shear deformation noticeable
<3	Shear deformation begins to dominate behaviour

- **Torsion** Show that torsional stiffness of members is not significant. With open sections, if effect of torsion is significant include warping torsion. With closed sections St Venant torsion theory likely to be adequate.

- **Connection eccentricity and size**

Connection eccentricity: The axial stiffness of an axial force member (EA/L) is reduced by a factor
$1 /(1 + (e/r)^2)$ due to an eccentricity 'e' from the longitudinal axis of the member to the joint intersection point (Figure 1). 'r' is the radius of gyration of the member about the axis which is at right angles to the line of eccentricity. A criterion $e/r<0.5$ could be applied.
Connection size. For moment connections, neglecting the finite size of the connection (Figure 2) is normally conservative but with walls it may be best to take account of the finite width using rigid arms from the wall centreline to the beam ends.

- **Rotational flexibility of a moment connection.** May be non-negligible in steelwork connections but no simple criterion for this is available. Acceptance of full connection rigidity should be based on degree of stiffening in the details of the connection. If a connection is assumed to have rotational stiffenss then it must be designed to take moment. With in-situ concrete, a moment connection would normally be accepted as rigid.

- **Foundation Restraints** For full fixity at a support the foundation should be massive and the connection detailed to take moment. For pin connections with a degree of rotational restraint, ensure that using a pin is conservative (likely to be acceptable for assessments of strength and deformation but may not be valid for dynamic analysis).

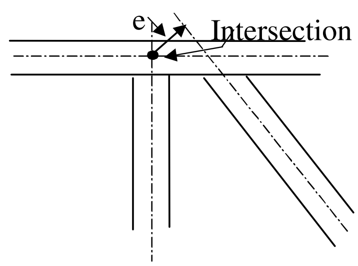

Figure 1 Axial force eccentricity

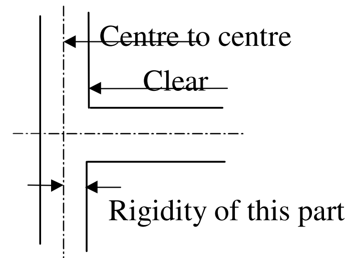

Figure 2 Beam to column connection

- **Small deformations including Euler buckling effect.** This assumption is normally valid due to use of code of practice rules for member sizing. For no-sway buckling of members results can be tested using the criterion $\lambda = N/N_{cr} < 0.1$ where N is the axial load and $N_{cr,euler}$ is the Euler buckling load.
  $N_{cr,euler} = \pi^2 EI/(kL)^2$ where I is the minor axis I value, L is the length between connections
  Typical values of the factor k are given in Table 1.

Table 1 k Values for Euler Buckling

End conditions	**k**
fixed- free (cantilever)	2.0
pin - pin	1.0
fixed - pin	.85
fixed – fixed	0.7
partial - partial	0.85

For overall buckling check $\lambda = N/N_{cr} < 0.1$ where N is the total load on the system and N_{cr} is the global buckling load.

- **Loading** Acceptance criteria for loading may be based on code or practice requirements but in non-standard situations the validity of the code methods for defining the loading may need to be questioned. In non-standard situations the validity of the loading may need to be assessed by testing (e.g. wind tunnel tests).

2. Results Verification

Verifying the results implies an attempt to answer the question "Has the model been correctly implemented?" The following items may be checked if relevant:

- Data check
- Sum of reactions = 0.0
- Restraints - no deformations at restrained freedoms
- Symmetry - check symmetry for symmetric structures with symmetrical loading.
- Check local equilibrium
- Form of results - internal forces (qualitative assessment)
- Form of results - deformations (qualitative assessment)
- Checking Model - internal forces (quantitative assessment)
- Checking Model - deformations (quantitative assessment)