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Effects of the Mass and Damping Matrix Model in the Non-Linear Seismic Response of Steel Frames

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Abstract : Seismic analysis of steel buildings is usually based on the use of the concentrated mass (ML) matrix and the Rayleigh damping matrix (C). Similarly, the initial stiffness matrix (KO) and the first two modes associated with lateral vibrations are commonly used to develop matrix C. The evaluation of the accuracy of these practices for the particular case of steel buildings with moment-resisting steel frames constitutes the main objective of this research. For this, the non-linear seismic responses of three models of steel frames, representing low-, medium- and high-rise steel buildings, are considered. Results indicate that if the ML matrix is used, shears and bending moments in columns are underestimated by up to 30% and 65%, respectively when compared to the corresponding results obtained with the consistent mass matrix (MC). It is also shown that if KO is used in C instead of the tangent stiffness matrix (Kt), axial loads in columns are underestimated by up to 80%. It is concluded that the consistent mass matrix should be used in the structural modelling of moment-resisting steel frames and that the tangent stiffness matrix should be used to develop the Rayleigh damping matrix.

Keywords : moment-resisting steel frames, consistent and concentrated mass matrices, non-linear seismic response, Rayleigh damping
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