Chapter 9

Modal Response Contribution

ABSTRACT

In order to optimize structure calculation, it is inconceivable to miss the understanding of the modal response contribution and truncation error. This chapter enlightens the reader on the subject by dealing with certain points, namely the determination of the elastic forces modal contribution, modal participation factors and truncation error, and static correction procedure. At the end of the chapter, examples will be treated in order to bring clarity to the reader on the points cited before.

INTRODUCTION

This chapter is imperative in order to understand the optimum calculation to better approach the actual behavior of the structure hence the development of certain key points namely, determination of the elastic forces modal contribution, modal participation factors, truncation error, and static correction procedure.

In ordre to compute the response contribution of the n^{th} mode it's imperative to perform static analysis of the structure, thus we can have modal static response. Then compte the pseudo-acceleration for the determination of the response due the n^{th} mode. At this stage we can combine the modal contributions to determine the total response (Chopra.2001) and (Jerome. 2012).

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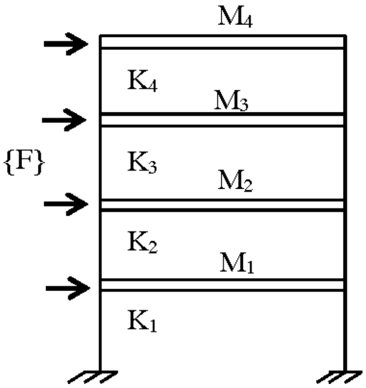
BRIEF REMINDER

Let us consider a system with several degrees of freedom.



Assuming that $\{F(t)\}=\{S\}g(t)$

Where $\{S\}=\sum_{i=1}^{n}\{S_i\}=\sum_{i=1}^{n}\Gamma_i[M]\{\varphi_i\}$

Premultiplying by $\{\phi\}$t we deduce that $\Gamma_i=\frac{1}{m_i^*}\{\varphi_i\}^t\{S\}$ which represents the modal participation factor

{S}: is the static load pattern

$$[M]_{(nxn)}\{\ddot{U}\}_{(n)}+[C]_{(nxn)}\{\dot{U}\}_{(n)}[K]_{(nxn)}\{U\}_{(n)}=\{F(t)\}_{(n)}=\{S\}g(t)=\sum_{i=1}^{n}\{S\}_i\,g(t)$$

By substituting $\{U(t)\}=[\phi]\{y(t)\}$

In addition, premultiplying by $[\phi]$t we have

$$[\varphi]^t[M][\varphi]\{\ddot{y}\}+[\varphi]^t[C][\varphi]\{\dot{y}\}+[\varphi]^t[M][\varphi]\{y\}=[\varphi]^t\{F(t)\}=[\varphi]^t\{s\}g(t)=[\varphi]^t\sum_{i=1}^{n}\{s\}_i\,g(t)$$

$$\left[M^*\right]\{\ddot{y}\}+\left[C^*\right]\{\dot{y}\}+\left[K^*\right]\{y\}=[\varphi]^t\{F(t)\}=\sum_{i=1}^{n}\Gamma_i[\varphi]^t[M]\{\varphi_i\}g(t)$$

$$M_i^*\ddot{y}_i+C_i^*\dot{y}_i+K_i^*y_i=\Gamma_iM_i^*g(t)$$

$$\ddot{y}_i+2\xi_i\omega_i\dot{y}_i+\omega_i^2y_i=\Gamma_ig(t) \tag{1}$$

The equation (1) describes ith modeWith $\Gamma_i=\frac{1}{M_i^*}\{\varphi_i\}^t\{S\}$ Modal participation factor (scales response of ith mode)

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