

# ProtaStructure Design Guide

Seismic Forces on Non-Structural Members (ASCE07-16)

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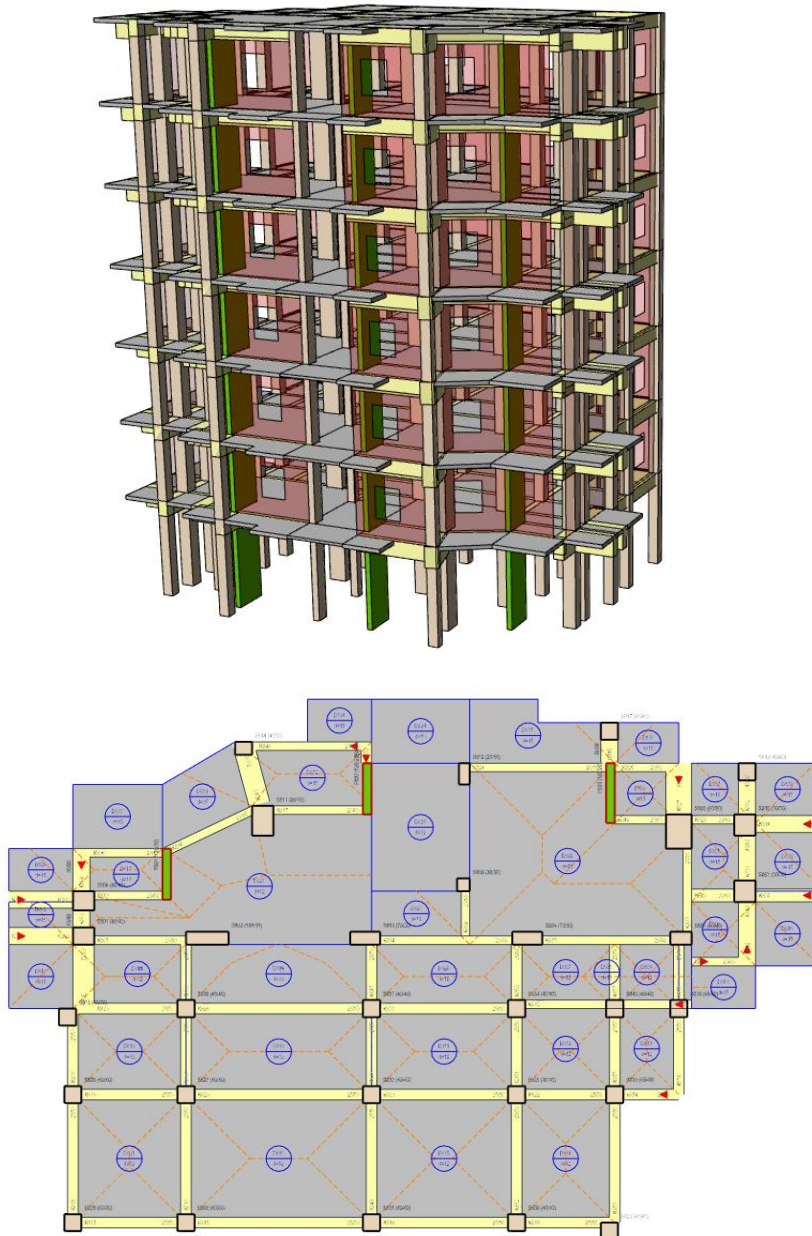
## Introduction

ProtaStructure calculates non-structural member forces according to **ASCE 7-16 Chapter 13.3**.

In the current document, calculations details about non-structural members earthquake force and parameters such as seismic coefficient are explained.

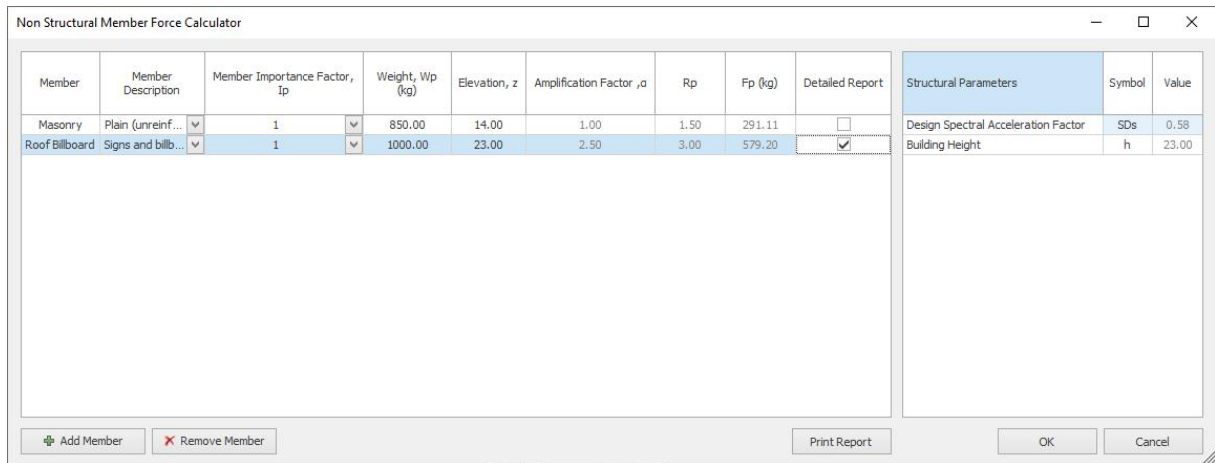
## Building Model Details

The building model consists of 7 regular floors. 3D and typical story plan view are shown below.



3D and Typical Plan View of Building Model

## User Interface



Member	Member Description	Member Importance Factor, $I_p$	Weight, $W_p$ (kg)	Elevation, $z$	Amplification Factor, $\alpha$	$R_p$	$F_p$ (kg)	Detailed Report
Masonry	Plain (unreinforced)	1	850.00	14.00	1.00	1.50	291.11	<input type="checkbox"/>
Roof Billboard	Signs and billboards	1	1000.00	23.00	2.50	3.00	579.20	<input checked="" type="checkbox"/>

Structural Parameters	Symbol	Value
Design Spectral Acceleration Factor	SDs	0.58
Building Height	h	23.00

At the “Non-structural Member Force Calculator” user interface, member label, non-structural member type according to **ASCE 7-16 Table 13.5-1 or 13.6-1**, member elevation from the base, and member weight are set by the user. The other parameters such as seismic coefficient and member forces are calculated according to **ASCE 7-16 Clause 13.3.11**.

## Seismic Force

According to **ASCE 7-16 13.3.1** horizontal seismic force,  $F_p$ , is defined as, “The horizontal seismic design force ( $F_p$ ) shall be applied at the component’s center of gravity and distributed relative to the component’s mass distribution”. Calculation details are given in subclause **13.3.1.1** which states the formula **(13.3-1)** given below.

$$F_p = \frac{0.4 \alpha_p S_{DS} W_p}{\frac{R_p}{I_p}} \left(1 + 2 \frac{z}{h}\right)$$

$S_{DS}$  : Spectral acceleration, short period, as determined from Section 11.4.5

$\alpha_p$  : Component amplification factor that varies from 1.00 to 2.50

$I_p$  : Component Importance factor that varies from 1.00 to 1.50

$W_p$  : Component operating weight

$R_p$  : Component response modification factor that varies from 1.00 to 12

$z$  : Height in the structure of point of attachment of component with respect to the base.

$h$  : Average roof height of structure with respect to the base

**Table 13.5-1 Coefficients for Architectural Components**

Architectural Component	$\alpha_p^a$	$R_p$	$\Omega_0^b$
Interior nonstructural walls and partitions <sup>c</sup>			
Plain (unreinforced) masonry walls	1	1½	1½
All other walls and partitions	1	2½	2
Cantilever elements (unbraced or braced to structural frame below its center of mass)			
Parapets and cantilever interior nonstructural walls	2½	2½	2
Chimneys where laterally braced or supported by the structural frame	2½	2½	2
Cantilever elements (braced to structural frame above)			
Access floors			
Special access floors (designed in accordance with Section 13.5.7.2)	1	2½	2
All other	1	1½	1½
Appendages and ornamentations	2½	2½	2
Signs and Billboards	2½	3	2
Other rigid components			

**Calculation Details**

$$\begin{aligned}
 S_{DS} &= 0.58 \\
 W_p &= 1000 \text{ kg} \\
 I_p &= 1.0 \\
 \alpha_p &= 2.5 \\
 R_p &= 3.0 \\
 z &= 23 \\
 h &= 23 \\
 \mathbf{F_p} &= \mathbf{579.20 \text{ kg}}
 \end{aligned}$$

According to ASCE 7-16 Clause 13.3.1.1 " $F_p$  is not required to be taken as greater than Formula (13.3-2) and  $F_p$  shall not be take as less than Formula (13.3-3)". ProtaStructure control these limits automatically.

$$F_{p,upperlimit} = 1.6 S_{DS} I_p W_p$$

$$F_{p,lowerlimit} = 0.3 S_{DS} I_p W_p$$

$$I_p = 1.0$$

$$W_p = 1000 \text{ kg}$$

$$S_{DS} = 0.585$$

$$\mathbf{F_{p,upperlimit} = 928 \text{ kg}}$$

$$\mathbf{F_{p,lowerlimit} = 174 \text{ kg}}$$

## Summary

In this document, calculation details of seismic forces acting on the non-structural elements according to **ASCE 7-16. Clause 13.3** is explained. Results of the “Non-Structural Member Force Calculator” macro are verified with hand calculations.

## Thank You...

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