EUCENTRE

European Centre for Training and Research in Earthquake Engineering

THE UNIVERSITY OF THE WEST INDIES

ORIENS EX OCCIDENTE LUX - A LIGHT RISING FROM THE WEST

SEISMIC RESEARCH CENTRE

Practical Examples employing the International Building Code (IBC) regulations and the New Seismic Hazard Maps for the Eastern Caribbean

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Practical Examples

- Get the design response spectra and the seismic coefficients Cs for the following sites at rock conditions:

1) Scarborough -Tobago (Building – 20 stories)

2) Indian River – Dominica (Bridge – 30 m multi-span intermediate columns with height H = 15 m)

Design spectral acceleration parameters IBC – ASCE 7 05

- $S_{DS} = 2/3 * F_a * S_s$ → Spectral acceleration for 0.2 s
- $S_{D1} = 2/3 * F_v * S_1$ → Spectral acceleration for 1.0 s

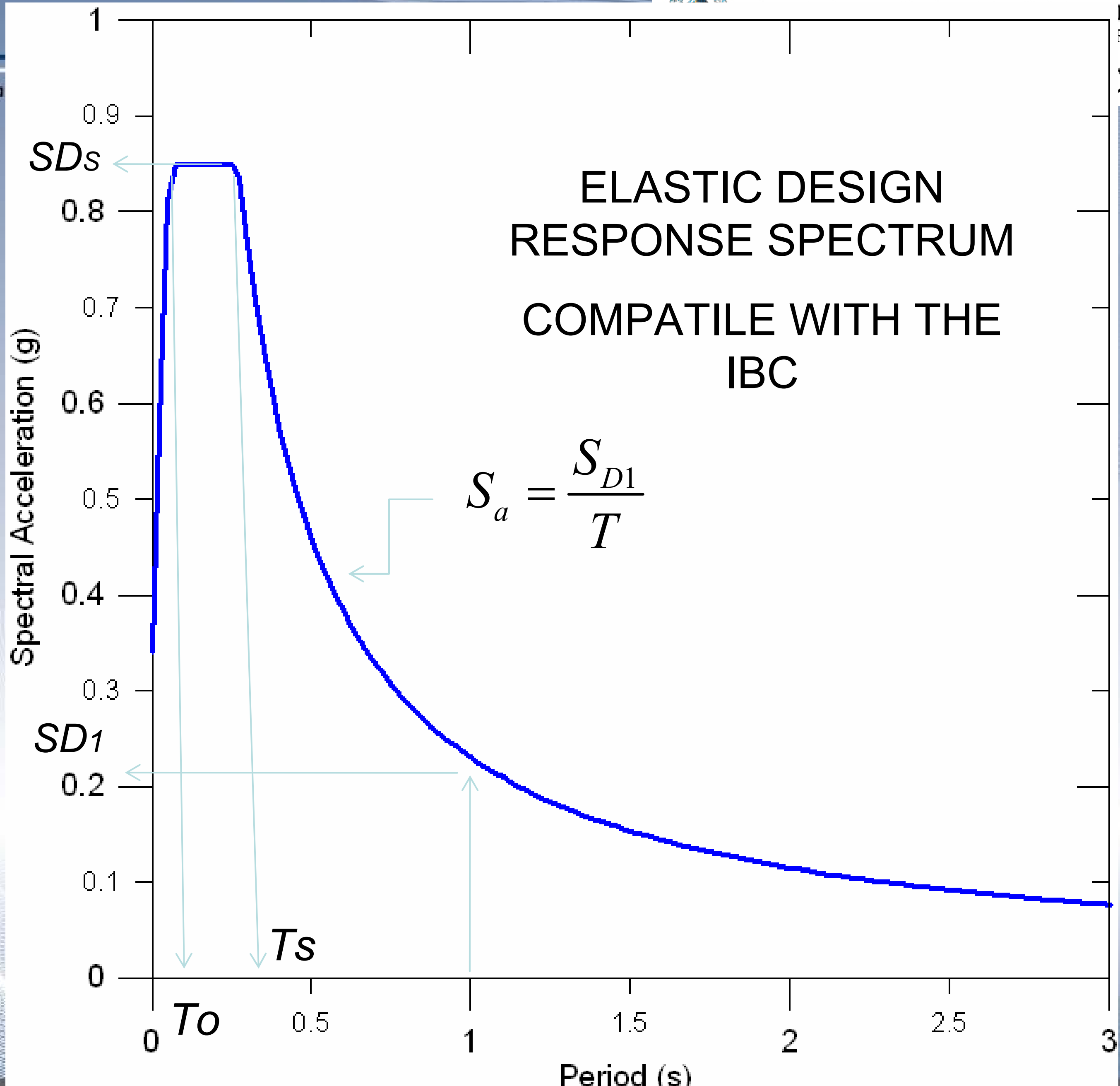
Obtained in the Seismic Hazard maps

F_a and F_v: depends on soil conditions

For rock site conditions – CLASS B

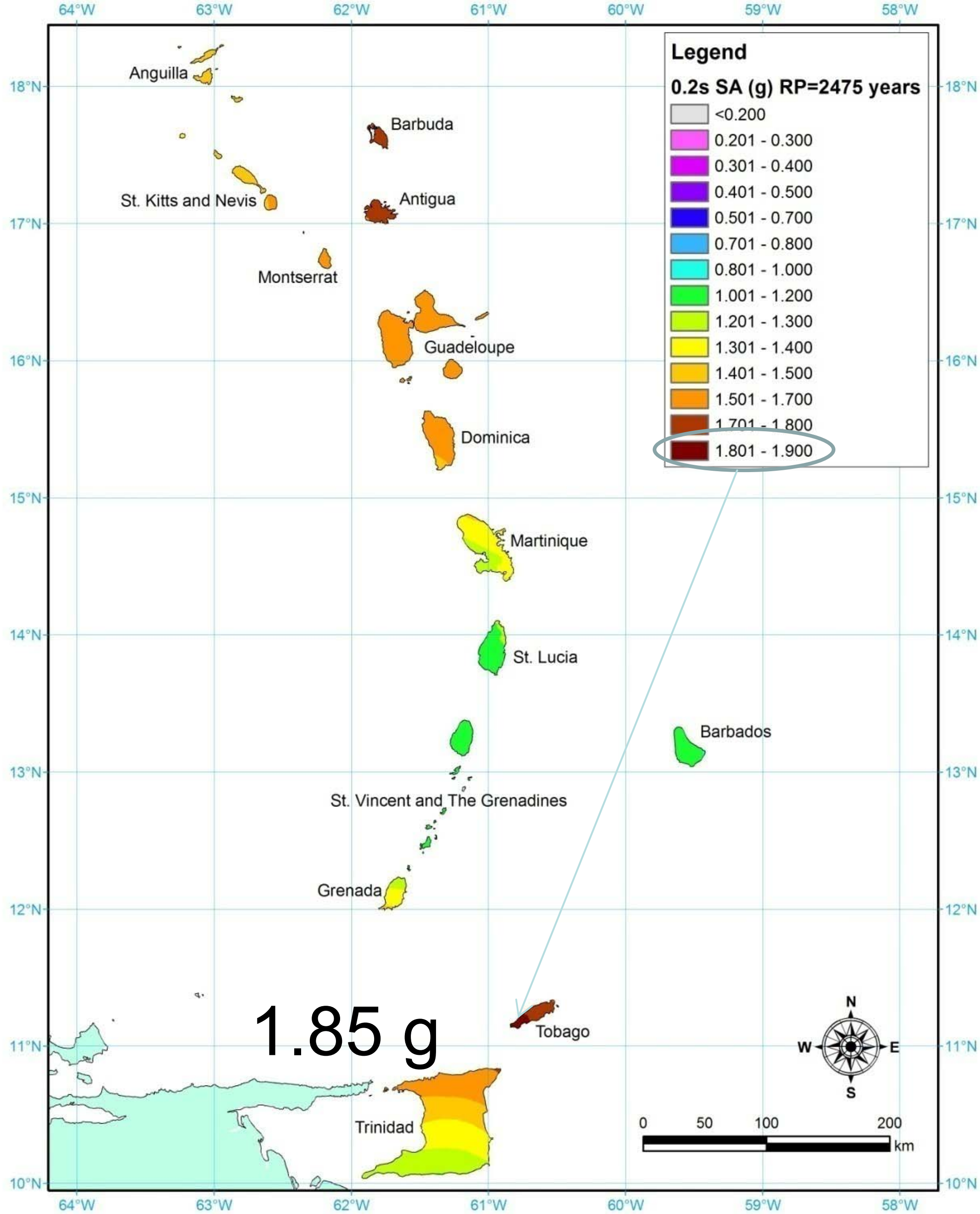
It Corresponds to a shear wave velocity Vs = 760 m/s:

$F_a = 1.0$ and $F_v = 1.0$


ELASTIC DESIGN RESPONSE SPECTRUM
COMPATILE WITH THE IBC
$S_a = \frac{S_{D1}}{T}$
SDs
SD1
To
Ts
Spectral Acceleration (g)
Period (s)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3

EXAMPLE 1: Scarborough -Tobago

Building – 20 stories


Legend
0.2s SA (g) RP=2475 years
<0.200
0.201 - 0.300
0.301 - 0.400
0.401 - 0.500
0.501 - 0.700
0.701 - 0.800
0.801 - 1.000
1.001 - 1.200
1.201 - 1.300
1.301 - 1.400
1.401 - 1.500
1.501 - 1.700
1.801 - 1.900
Anguilla
Barbuda
St. Kitts and Nevis
Antigua
Montserrat
Guadeloupe
Dominica
Martinique
St. Lucia
Barbados
St. Vincent and The Grenadines
Grenada
Tobago
Trinidad
1.85 g
N
W
E
S
0
50
100
200
km

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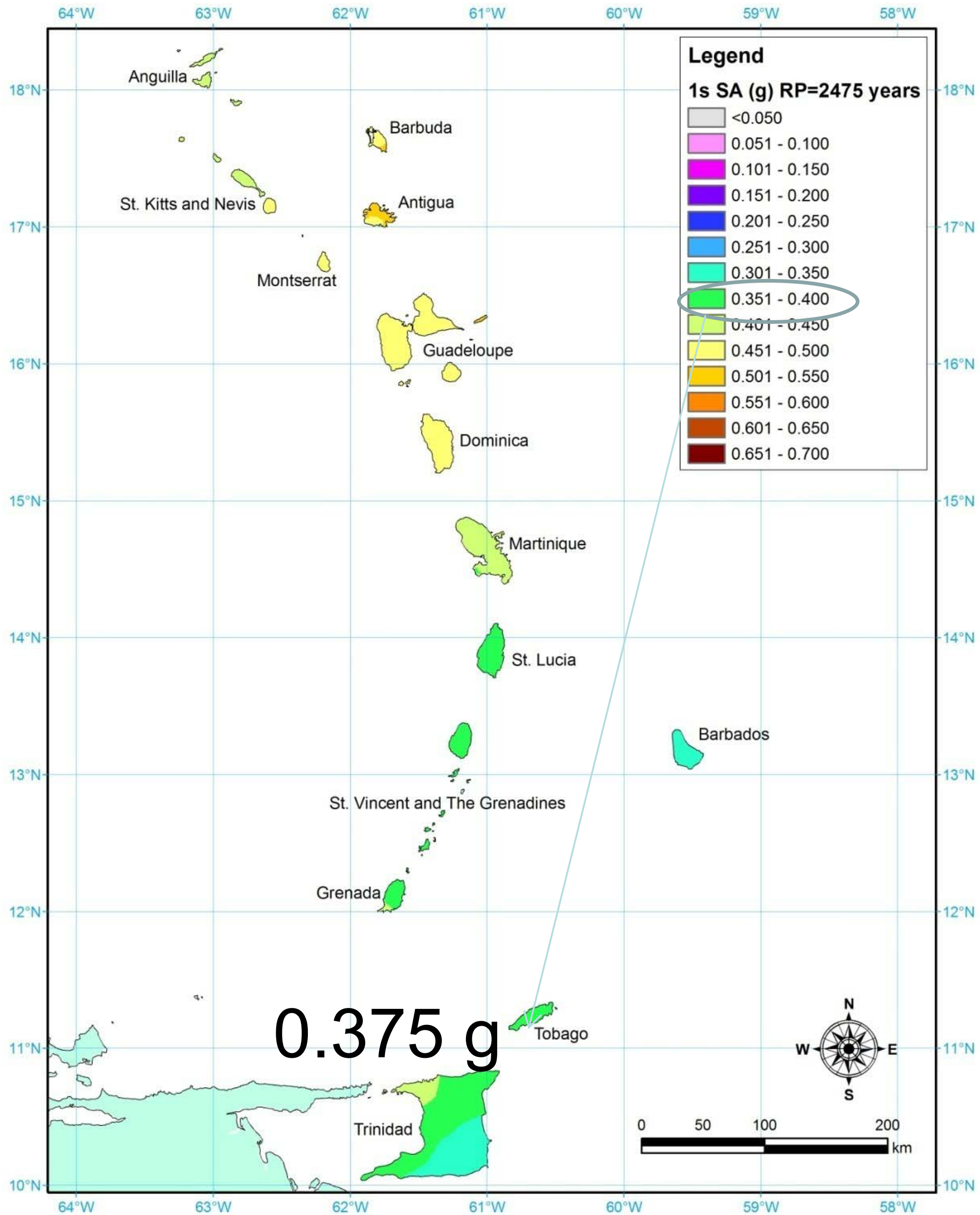


- Reading from the maps

$$S_S = 1.85g$$
$$S_1 = 0.375g$$

$$S_{DS} = (2/3)*1.85g = 1.23g$$
$$S_{D1} = (2/3)*0.375g = 0.25g$$

$$T_o = 0.2\frac{S_{D1}}{S_{DS}} = 0.2*\frac{0.25}{1.23} = 0.04s$$

$$S_a = S_{DS}\left(0.4 + 0.6\frac{T}{T_o}\right) = 1.23*\left(0.4 + 0.6\frac{T}{0.04}\right) = 0.492 + 18.45T$$

T : the fundamental period
of the structure in “s”

$$S_a = S_{DS} = 1.23g$$

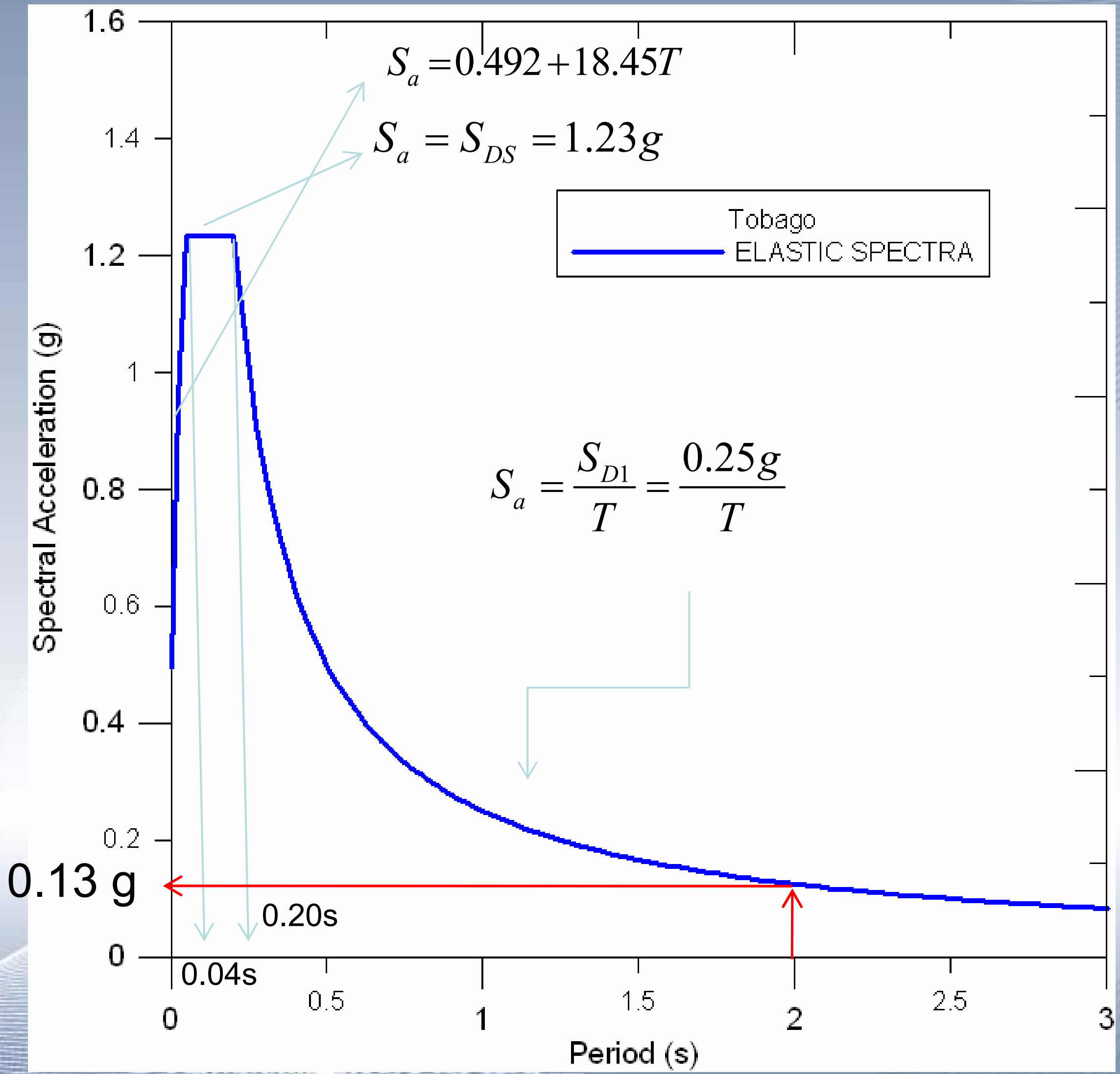
Flat spectral response

$$T_S = \frac{S_{D1}}{S_{DS}} = \frac{0.25}{1.23} = 0.20s$$

Period to which begin the exponential decay

$$S_a = \frac{S_{D1}}{T} = \frac{0.25g}{T}$$

Spectral exponential decay



The Seismic Coefficient Cs

Fundamental Period:

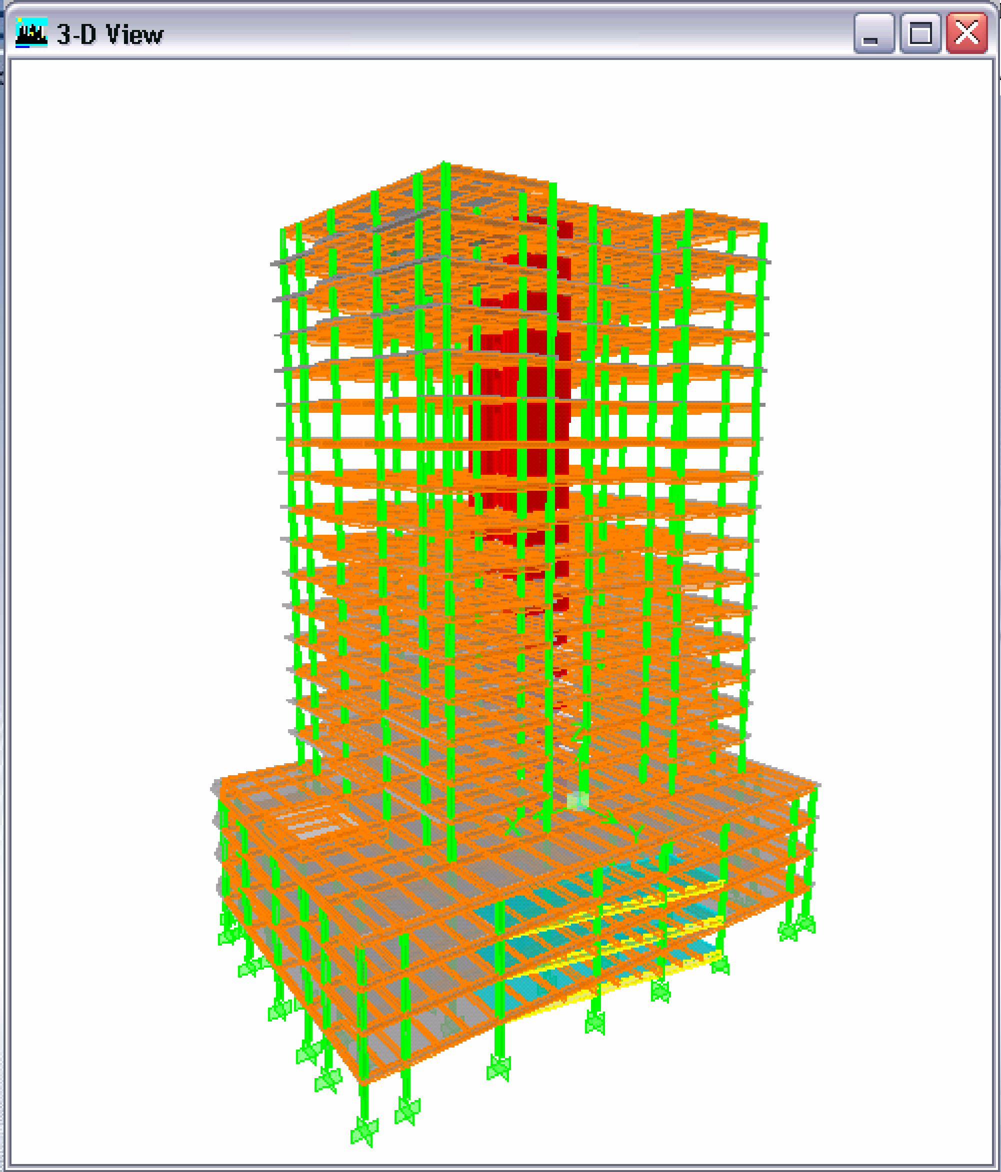
T = 2.0 s (after dynamic analysis)

SA = 0.13g (elastic spectral acceleration)

Reduction factor R= 8.0 considering ductility and overstrength

Seismic design coefficient:

Cs = SA/R=0.13g/8=0.016g

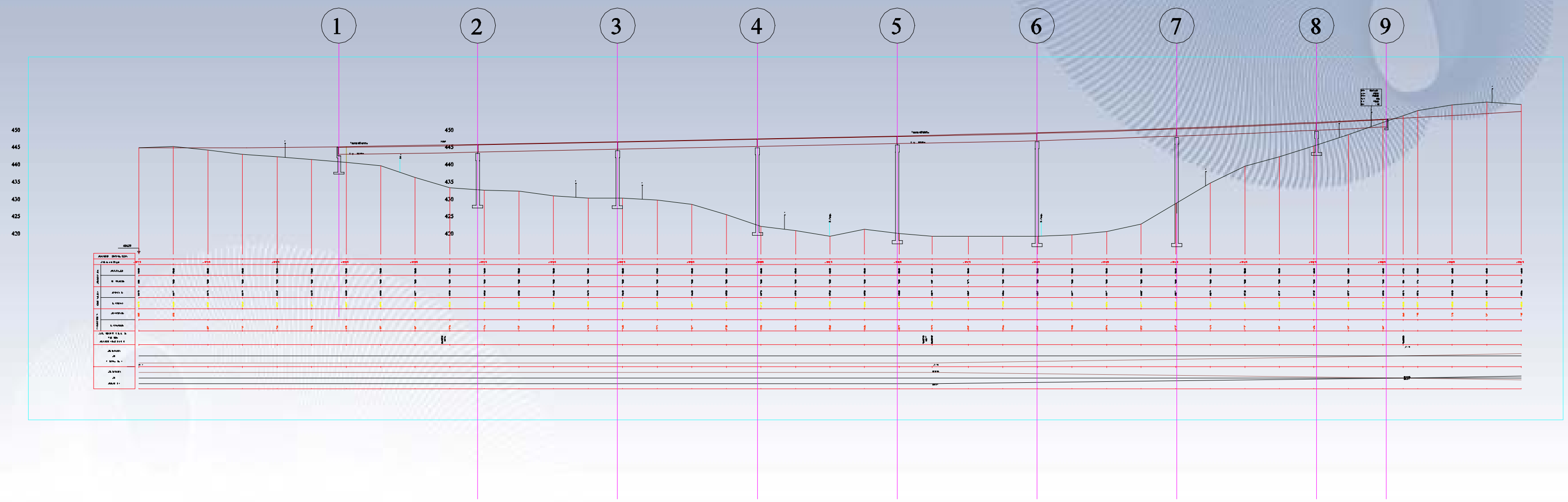


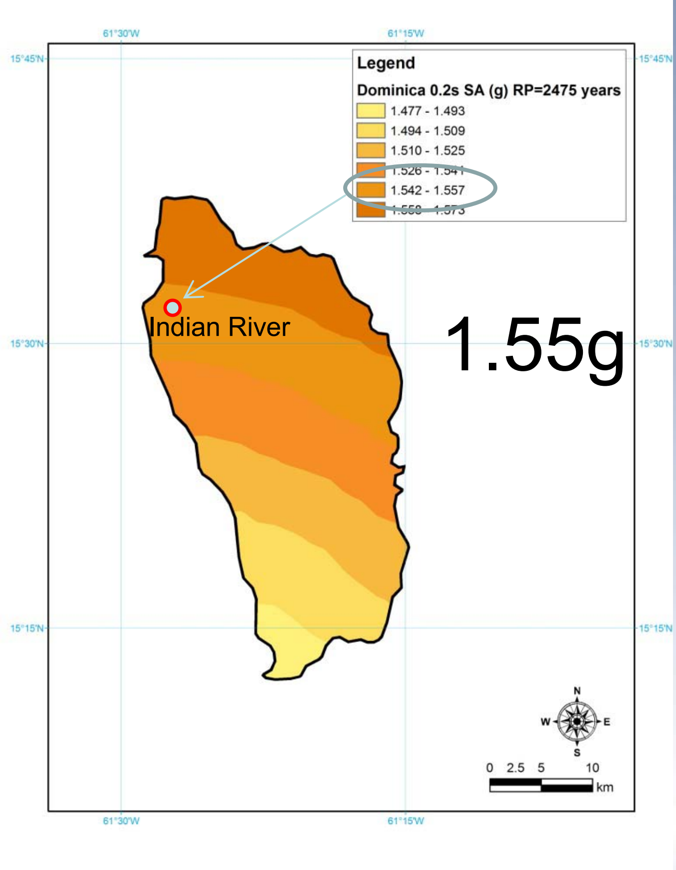
SAP MODEL FOR THE 20 STORY BUILDING

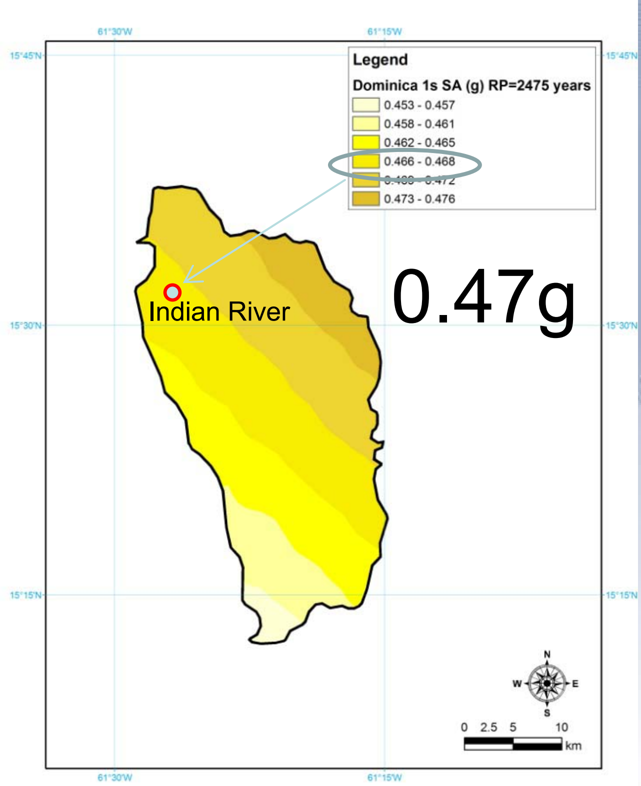
EXAMPLE 2: MULTI SPAN BRIDGE

INDIAN RIVER - DOMINICA

MULTI SPAN BRIDGE
INDIAN RIVER - DOMINICA




Legend
Dominica 0.2s SA (g) RP=2475 years
1.477 - 1.493
1.494 - 1.509
1.510 - 1.525
1.542 - 1.557
Indian River
1.55g
0 2.5 5 10
km


Legend
Dominica 1s SA (g) RP=2475 years
0.453 - 0.457
0.458 - 0.461
0.462 - 0.465
0.466 - 0.468
0.473 - 0.476
Indian River
0.47g
0 2.5 5 10
km

- Reading from the maps

$$S_S = 1.55g$$
$$S_1 = 0.47g$$

$$S_{DS} = (2/3)*1.55g = 1.03g$$
$$S_{D1} = (2/3)*0.47g = 0.31g$$

$$T_o = 0.2\frac{S_{D1}}{S_{DS}} = 0.2*\frac{0.31}{1.03} = 0.06s$$

$$S_a = S_{DS}\left(0.4 + 0.6\frac{T}{T_o}\right) = 1.03*\left(0.4 + 0.6\frac{T}{0.06}\right) = 0.41 + 10.3T$$

T : the fundamental period
of the structure in “s”

$$S_a = S_{DS} = 1.03g$$

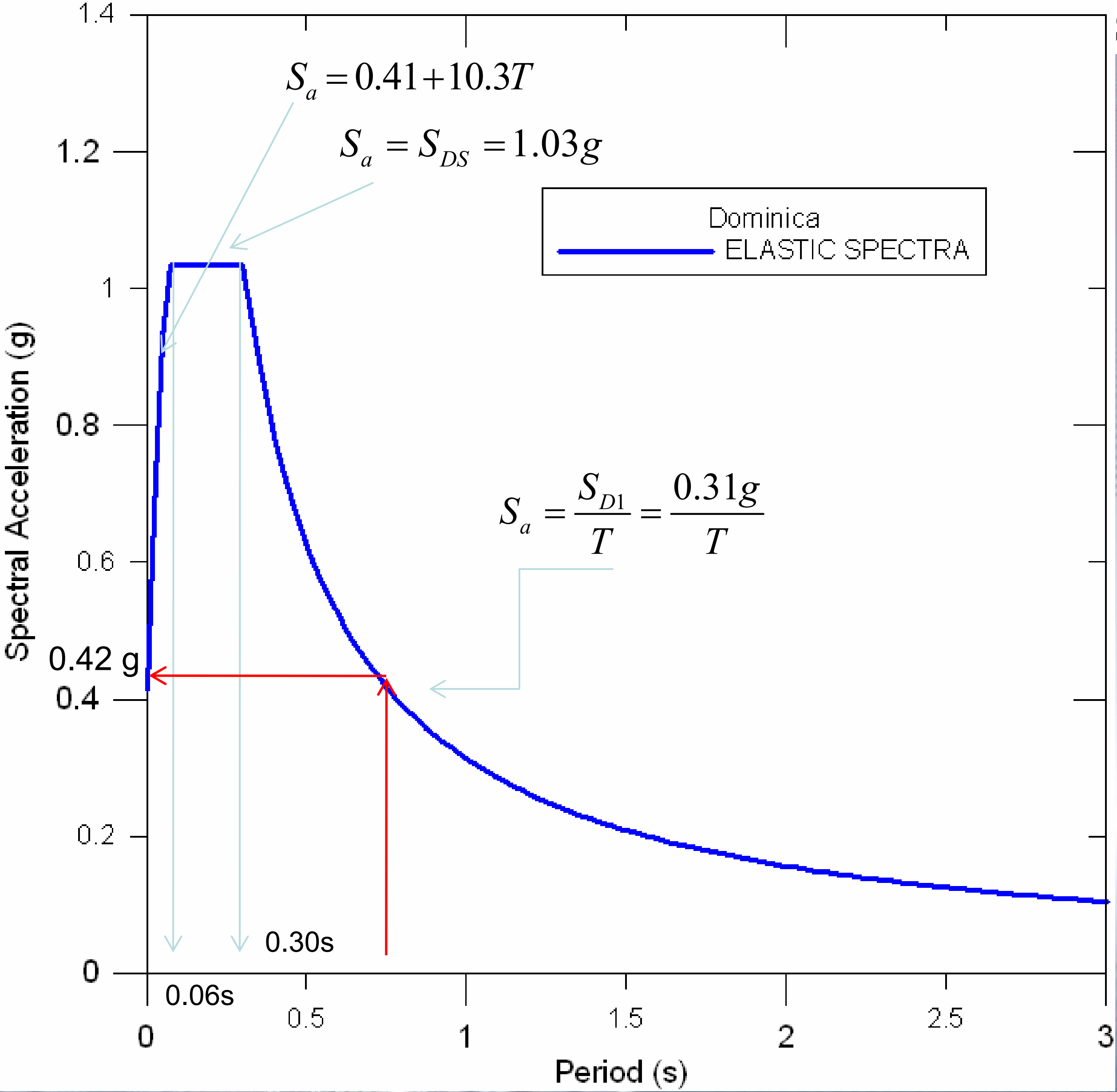
Flat spectral response

$$T_S = \frac{S_{D1}}{S_{DS}} = \frac{0.31}{1.03} = 0.30s$$

Period to which begin the exponential decay

$$S_a = \frac{S_{D1}}{T} = \frac{0.31g}{T}$$

Spectral exponential decay



The Seismic Coefficient Cs

Design of a column

Fundamental Period (after dynamic analysis):

T = 0.75 s (H=15 m and 30 m span)

SA = 0.42g (elastic spectral acceleration))

Reduction factor R= 8.0

Considering ductility and overstrength

Cs = SA/R =0.42g/8=0.053g