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Spectrum Response –Structure

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1 Abstract

. The major problem of structural engineering is estimating the behavior of a structure subject to ground motion. Many factors affect EQ loads, including, among other things: the nature of the soil, building heights, relative differences between building heights, spaces between adjacent buildings, the structural system resisting lateral loads, the location of collision points, and the peak ground acceleration of the earthquake at the building site.

Therefore, understanding the spectrum response is the basic input for introducing earthquake loads on structural structures. Therefore, this research focused on spectral response, the history of its origin, and its philosophy. It was presented through some symbols and the factors, variables, and equations they stipulated, within the framework of the same goal, which is to formulate a deep idea about the spectrum response curve.

Keywords : Spectrum Response –Structure

1.1 Problem

The satisfactory design of the components is highly dependent on the adequate knowledge of the material behavior and operational conditions. For the structures under earthquakes, often this information is not available is incomplete or inaccurate, and leads to increases the risk of the possible failures.

1.2 Target

Studying the spectrum response, the factors involved in it, and its outputs as an input for the vertical and vertical earthquake loads on the structures.

1.3 Limits

The study was examined from the point of view of the Egyptian-Saudi code – ASCE For concrete structures.

2 Introduction

An earthquake is defined as an unexpected, unpredictable, and uncontrollable natural event that occurs in seismic zones. Therefore, if a structural structure can withstand a large change in inelastic deformation, without instability, it is said to have shown positive behavior. Design engineers believe that materials and connections with high elasticity and appropriate strength must be selected to prevent fractures caused by earthquakes and their effects.

One attempt to simplify this problem has involved the introduction of the so-called “response spectrum”.

As for the seismic design of construction structures, simplified response spectra that represent a risk to the structure are used. These spectra represent average values from several earthquake scenarios and probabilities that could affect the structure under study.

For the practical seismic design of structures, simplified response spectra that represent the hazard of a site are used. These spectra represent average values from many possible earthquake scenarios that could affect the site under consideration.

These results and values, which were deduced by studying the spectral curves of many earthquake records, represent the average relationship between different ground seismic parameters. For a given region, it is measured directly to the maximum design acceleration, which is an equation and a function of the seismic hazard in the region. The simplified spectrum is obtained by multiplying each branch of the ground parameters by an amplification factor that depends on the damping coefficient of the structure and the target exceedance probability. For seismic design of structures of significant importance, it has been suggested that values corresponding to a probability of exceeding 50% can be used.

Based on these concepts, design codes define design response spectra for all the different regions in their territory of application.

The design response spectrum is used to determine the design spectral response accelerations for a given structure. After calculating design response acceleration coefficients SDS and SD1, the design response spectrum curve should be constructed as follows:

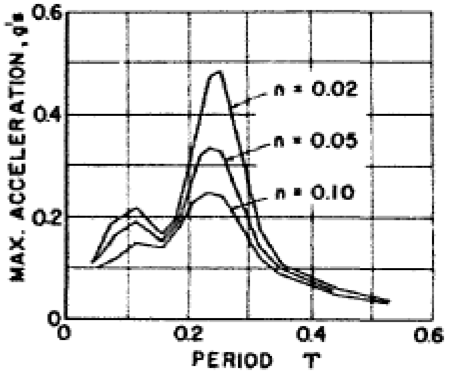
For example :In the USA, the probabilistic approach is treated. For each specific site, you define a Maximum.

Considered Earthquake (MCE) (an event with a 2% probability of exceedance in 50 years or a Tr = 2475 years). The design earthquake is 2/3 the MCE. Response spectrum curves (ASCE)

3 Definitions

3.1 Spectrum Response:

The Response Spectrum is a graph that represents the dynamic response of a system, such as a structure or the ground, in the frequency domain. It involves transforming the dynamic response in the time domain into the frequency domain, aiding in understanding the dynamic characteristics of the system. Widely used in seismic and structural engineering, the Response Spectrum predicts and analyzes the response of structures under dynamic loads, particularly seismic conditions.



(c) ACCELERATION RESPONSE SPECTRUM

Figure “1”

Characteristic	**Displacement Response Spectrum**	**Acceleration Response Spectrum**	**Velocity Response Spectrum**
Definition	Frequency domain analysis of the displacement of structures or ground	Frequency domain analysis of the acceleration of structures or ground	Frequency domain analysis of the velocity of structures or ground
Unit	mm or m	m/s² or g	m/s or mm/s
Time-Frequency Transformation	Uses Fourier Transform	Uses Fourier Transform	Uses Fourier Transform
Type of Response	Displacement	Acceleration	Velocity
Application	Used for analyzing fundamental frequencies and higher modes of structures, among other things	Utilized in seismic analysis and assessment of structure response to dynamic loads such as earthquakes	Applied in seismic analysis and assessing structure response to dynamic loads like earthquakes
Safety Assessment and Seismic Analysis	Assessing building fundamental frequencies and modes, among other uses	Assessing structure response to dynamic loads such as earthquakes	Evaluating structure response to dynamic loads like earthquake

Table “1”

3.2 Response-spectrum analysis (RSA)

It is a dynamic linear statistical analysis method that identifies and measures the contribution from each normal mode of vibration to indicate the maximum potential seismic response for a fundamentally elastic structure. Response spectrum analysis provides insight into dynamic behavior by measuring pseudo-spectral acceleration, velocity or displacement as a function of the structural period for a given time history and damping level. It is practical to wrap the different response spectra so that the smooth curve represents the highest response for each investigation for a structural period.

Response spectrum analysis is very useful in design in terms of making design decisions because it links the choice of structural type to dynamic performance. Structures with a shorter period undergo greater acceleration, while structures with a longer period undergo greater displacement. Structural performance objectives should be taken into account during preliminary design and response spectrum analysis.

3.3 Ground motion :

Ground motion is the movement of the Earth's surface from earthquakes or explosions. Ground motion is produced by seismic waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the Earth and along its surface.

4 Spectrum criticism

The use of response spectrum has frequently been criticized on the ground that is not possible to represent a complex structure By the very simplified model containing only the single mass,spring.dashpot

5 History of Spectrum Response

Theodore von Kármán and Maurice Biot

5.1 The mathematical formulation of the RSM “response spectrum method “first shown in the doctoral dissertation of M.A. Biot in 1932 and in two of his papers (Biot 1932a, 1933, 1934a).

5.2 Biot defended his Ph.D. thesis at Caltech in June 1932 (Biot 2007a) and submitted a lecture on the method to the Seismological Society of America meeting, held at Caltech, the same month.

5.3 Theodore von Kármán (von Kármán and Edson 1967), Biot’s advisor, played the main role in guiding his student and in promoting his accomplishments.

5.4 After the method of solution was formulated, Biot and von Kármán searched for an optimistic design method

5.5 The debate at the time was whether the structure should be designed with a simple first floor or be rigid throughout its height, to withstand the required seismic force. An excerpt from the New York Herald Tribune in June explains this

6 Response Spectrum Method

Here we refer to history of the RSM as Biot's sum of absolute maxima—e.g., Amini and Trifunac 1985.

Finally, on page 215, Biot discussed the characteristics of the spectral distribution, and mentions Suyehiro's observations in Japan.

He then concluded: "If we possessed a great number of seismogram spectra we could use their envelope as a standard spectral curve for the evaluation of the probable maximum effect on buildings."

7 Response spectrum in design

Reported in his 1934a paper, Piot argued that if a sufficient number of seismic spectra were available, it would be possible to use their envelope as a standard spectral curve to evaluate the potential higher impact on

Structures - see Philosophy Article No. 12. He continued in Biot (1941): "These standard curves... can be made to depend on the nature and magnitude of the damping and on the location. Although the previously analyzed information does not lead us to definitive conclusions, we... conclude that the spectrum will generally be a decreasing function with the time period of the latter values greater than about 0.2 s. The standard curve for the Helena and Ferndale earthquakes can be...For $T > 0.2$ s, it is a simple hyperbola, and for $T < 0.2$ s, $A = g\ (4T + 0.2)$, where T is the time period in seconds and g is the gravitational acceleration. Whether this function is suitable for other earthquakes can only be determined through further investigation.

8 Modal Analysis

Before beginning to discuss response spectrum analysis, it is important to have an integrated understanding of modal analysis

Also known as the super-directed method. The aim of the optimal model analysis is to move a perfectly coupled problem from N degrees of freedom to N single-degree-of-freedom (SDOF) problems that can be solved individually, and finally, the individual solutions may be imposed to deduce the solution of the initially coupled problem.

The biggest advantage is that simpler methods, which impose closed methods, can be used to solve the single degree of freedom problem. From a computing point of view, the number of operations required is further reduced when modal decomposition is preferred (Bathe 1996).

Another reason is that a smaller number of modes must be taken into account, while the rest can be neglected with minimal loss of accuracy.

This speeds up the entire process and solutions further, while the number of target modes depends on the type of loading and structural characteristics.

A major property of modal analysis is that the response can be performed accurately if a relatively smaller number of arguments are taken into account. The question remains: What is the number of situations that should be included in the model analysis?

The answer based on the structural load and the response parameter examined. For example, we need more modes and positions to accurately capture bottom shear than roof displacement.

Because the most accurate solution is not known in advance, the engineer must determine which response factors are likely to be most sensitive to high modes and then determine how many modes to imposed

In general, some structure codes indicate that the number of modes taken into account should be chosen as a number that brings the effective typical masses of the modes taken into account to at least 90% of the total mass of the structure.

Due to the nature of the relationship between effective modal mass and principal shear, this concept indicates that the error in evaluating principal shear should be less than 10%. Furthermore, according to the Eurocode 8 standard (EC8 2004), the analysis must include all media with effective modal masses greater than 5% of the total

9 Response Spectrum details

In seismic design problems, in most positions, it is sadequate to know only the max. values of the

response, defined as the maximum of the absolute value of a response quantity r(t) that changes in time

(Chopra 2005):

r0 = max (rt)

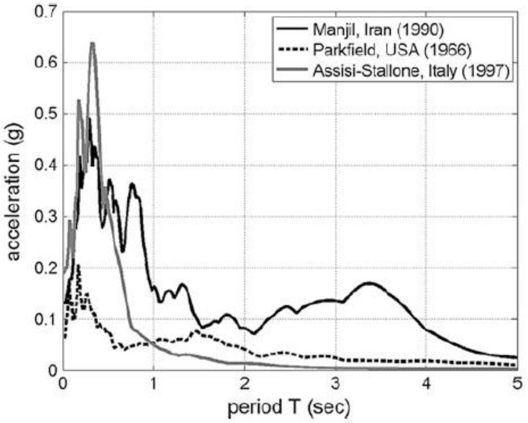
where r0 is the absolute value of r(t). The response spectrum of a quantity is the plot of the maximum value of a response quantity (e.g., displacement, velocity, acceleration) against the total range of interest of the natural vibration period values Tn.

The expression “spectral curve” was first used in the sciences of optics and not structural engineering to describe the rainbow of colors in visible light as they are separated using a prism. In other words, “spectrum” refers to a broad range of studies, conditions, or behaviors that are grouped and studied together.

If a given period value Tn refers to a different SDOF structure, a response spectrum of a quantity by definition

provides the max. value of the response quantity of interest because of a given ground motion for the whole range of structures of interest. Therefore, such plots give the maximum response for the whole range (or spectrum) of SDOF structures.

10 Properties of Response Spectra



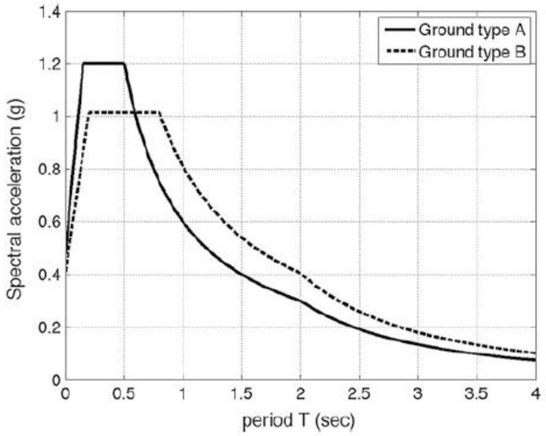
Acceleration response spectra for three strong ground motion records

Figure”2”

Figure 2 refers to the response spectra of three recorded ground motion records. Some very interesting observations regarding the properties of the response spectra can be made.

All three spectra intersect the vertical axis at an acceleration value equal to the max ground acceleration, i.e., the maximum acceleration value of the recorded ground motion.

This view corresponds to a high rigid SDOF system with period equal to zero ,Moreover, Manjil (1990) and Assisi Stallone's (1997) ground motion are more robust compared to Parkfield's (1966) record, noting that Manjil record contains richer scientific and practical material and frequency results compared to Assisi Stallone's record. This results from the fact that the Manjil record maintains high acceleration values over a large time scale, while the Assisi-Stallone spectrum decays rapidly. The rich frequency content in the Parkfield register is also noted.



The elastic design spectrum of European Committee for Standardisation (2004)

Figure”3”

$$S_a(T,\xi) = \begin{cases} \alpha_g\, S\,[1 + (\eta 2.5 - 1)(T/T_B)] & ,\ \text{if } 0 \le T \le T_B \\ \alpha_g\, S\eta\, 2.5 & ,\ \text{if } T_B \le T \le T_C \\ \alpha_g\, S\eta\, 2.5\,(T_C/T) & ,\ \text{if } T_C \le T \le T_D \\ \alpha_g\, S\eta\, 2.5\,\left(T_C T_D/T^2\right) & ,\ \text{if } T_D \le T \le 4sec \end{cases}$$

ɳ=√(10/(5+ ξ))≥0.55
S”soil factor “ and Tb-Tc-Td and Td They are “time values “that change the shape of the spectrum based on the nature and characteristics of the soil. Eurocode 8 recommends the above spectrum for earthquakes greater than 5.5, while another expression is recommended for smaller earthquakes. . is the damping correction factor equal to 1 when ξ = 5% (typical for reinforced concrete structures) and is generated as − ξ is the damping
αg :is the design acceleration which is equal to the importance factor ɣ1 times the design peak ground
acceleration (PGA). Figure 3 shows 2 response spectra obtained with the formula.
The spectrum with the solid line refers to ground type A with parameters (S=1.2, TB=0.15, TC=0.5, TD=2.0) and used for the design of a reinforced concrete structure (ξ = 5 %). The importance factor (1ɣ) is considered = 1.0 and the design PGA = 0.40 g.
The spectrum with the dashed line refers to ground type B with parameters (S=1.35, TB= 0.2, TC = 0.8, TD= 2.0), PGA = 0.30 g, and 1.0= 1ɣ.

11 Creation of response spectrum

For simple building one degree of freedom, any seismic force cause relative displacement “u” in time period “ t” .
As mass of structure increased “M” as relative displacement “u” increased-see figure “8 “.
Relations among U ,M ,V” shear “ ,t mentioned as below
The main purpose of specialist is to create a spectrum response curve enable to get acceleration depending on t ,
So all countries were divided to seismic zones and experimental tests were done based on subjecting a structure “single degree of freedom -SDOF“ in same area to multi seismic forces ,then drawing relation curve between t and acceleration for each case in same spectrum response – see “ 9 “ .but no data can be given from this easily
The next step scientists creating an envelope spectrum response see “ 10 “

From this enveloped spectrum all needed informations can be given or calculated see followed equations

12 Philosophy

To study spectrum Response the following must be understood

A simple structure “one story - single degree of freedom”

It is usual that it is fixed from below and free from above. In the event of an earthquake or vibrations, it moves “Relative displacement U“ from above and rebounds over a certain period of time. The greater the mass”M”, the greater the time period. That is, the relationship between the mass and the time period is direct.see fig “7”

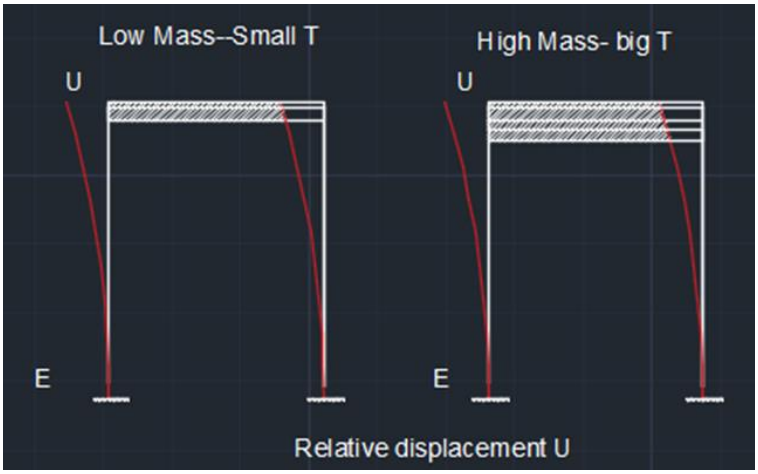


Fig “7”

12.1 Time required to finish 1 cycle of vibration

depending on mass M and Stiffness K of structure

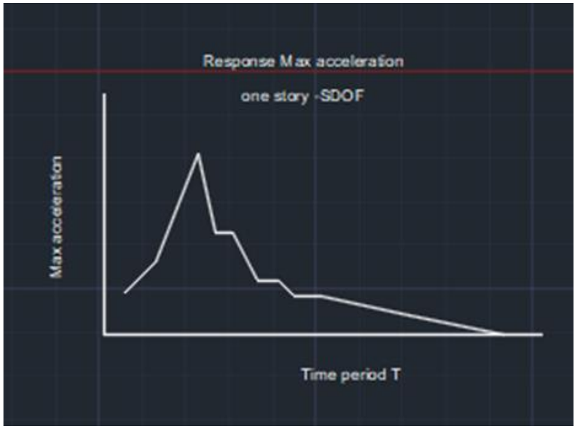
T=2π*SQRT(M*K)

Shear force V=U*K

Acceleration (a)=V/M=U*(K/M)=U*(2 π/T)^2

12.2 Obtaining Response spectrum

To create the Response spectrum, countries were divided into seismic zones, and scientists and specialists exposed a simple structure with single degree of freedom to vibrations to simulate an earthquake, and then drew the relationship between time period and acceleration.See Fig “8”



Fig”8”

However, the same structure in the same seismic zone may be exposed to earthquakes of different strength, which has led to the relationship between time and acceleration being drawn in several curves, as shown in Fig”9”

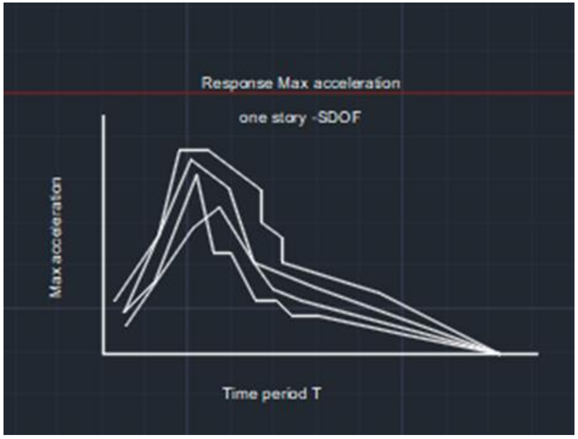


Fig “9”

To facilitate the inference of duration and acceleration values, these curves are combined for the same seismic region As Envelope spectrum Response see Fig “10”

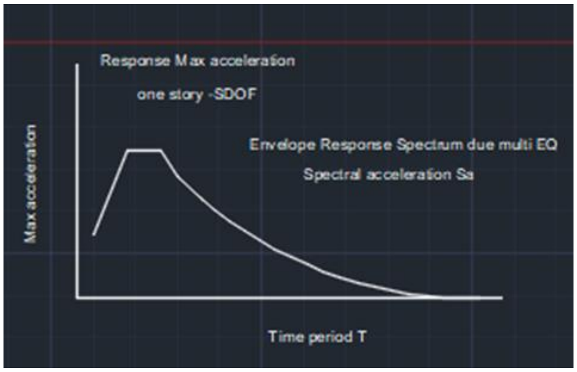
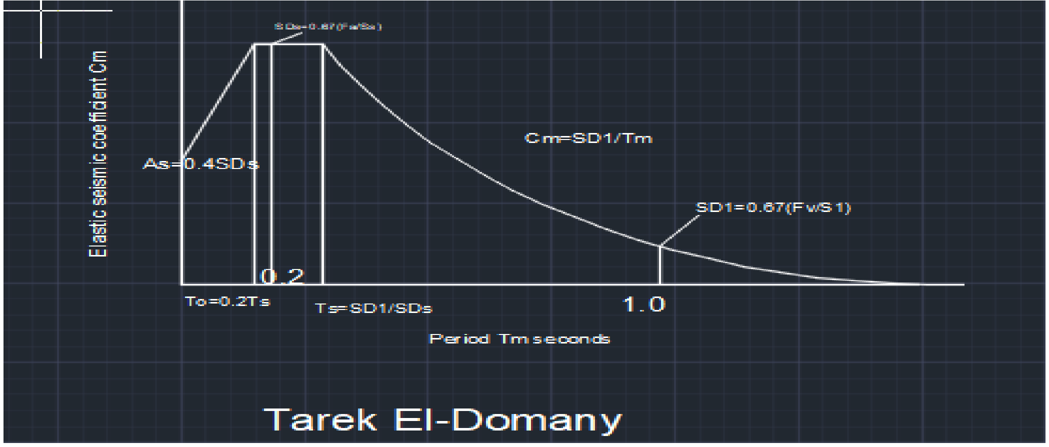


Fig “10”

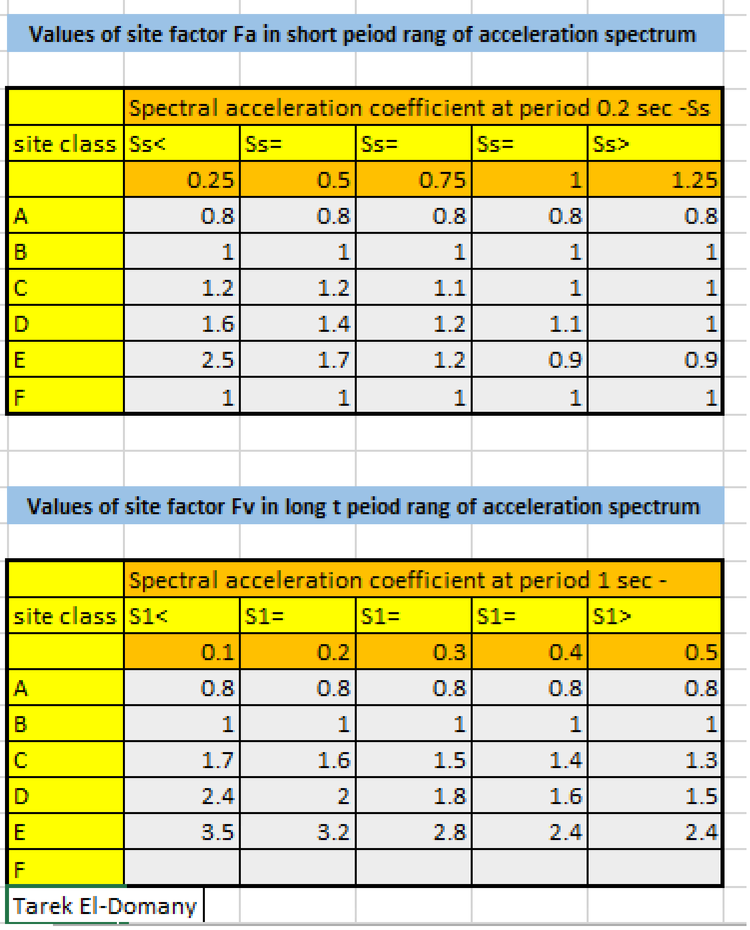
13 Response spectrum in various codes

13.1 Saudi code

Reference: LRFD code
Ss is the ground motion in 0.2 second
S1 is the ground motion in 1 second
You can get these values from Saudi maps for each area
Fv And Fa factors depended on soil type see table " 2 "
See spectrum " 4 &5 "
Based on Location and soil type to get time period T vs Sa
SDs=0.67(Fa*Ss)
SD1=0.67(Fv*S1)
Ts=SD1/SDs
T0=0.2 Ts
From maps fined Ss ,S1 and period TL
Ss and S1 considered as percentages of g



Fig"4"



Values of site factor Fa in short peiod rang of acceleration spectrum

	Spectral acceleration coefficient at period 0.2 sec -Ss				
site class	Ss<	Ss=	Ss=	Ss=	Ss>
	0.25	0.5	0.75	1	1.25
A	0.8	0.8	0.8	0.8	0.8
B	1	1	1	1	1
C	1.2	1.2	1.1	1	1
D	1.6	1.4	1.2	1.1	1
E	2.5	1.7	1.2	0.9	0.9
F	1	1	1	1	1

Values of site factor Fv in long t peiod rang of acceleration spectrum

	Spectral acceleration coefficient at period 1 sec -				
site class	S1<	S1=	S1=	S1=	S1>
	0.1	0.2	0.3	0.4	0.5
A	0.8	0.8	0.8	0.8	0.8
B	1	1	1	1	1
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F					

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Table “2”

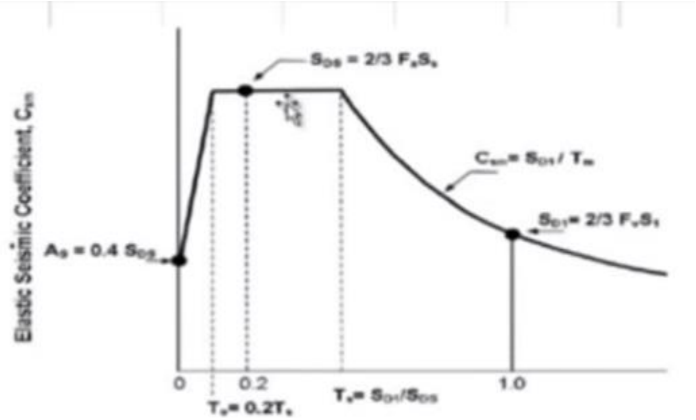


Fig “5”

Where

SDS = the design spectral response acceleration parameter at short periods(0.2 sec)

SD1 = the design spectral response acceleration parameter at 1-s period

T = the fundamental period of the structure, (s).

13.2 ASCE7-10

13.2.1 Approach

Earthquake ground motion is normally recorded as an acceleration of the ground at a particular location. The acceleration of the ground generates the acceleration of the structure (response acceleration), which cause earthquake forces that act on the structure. Earthquake forces generate deformations, relative displacement , internal forces, and stresses in the structure.

So, the first step to design an earthquake-resistant structure is to know the maximum possible response acceleration that can occur during an earthquake. It is also important to know that the response of the given structure depends on the time period of vibration and damping characteristics of the structure.

The ASCE 7-10, Section 11.4.5 describes the procedure to determine the design response.

Spectrum curve, from which the design response acceleration, Sa, for any given period of vibration T, is estimated. One part of this procedure is the determination of the spectral response acceleration factors for short periods, SDS, and for a 1-second period, SD1.

Design earthquake spectral response acceleration parameter at a short period, SDS, and at 1 s period, SD1, shall be determined from Eqs. 11.4-3 and 11.4-4, respectively.

SDS=2/3(SMS)
SD1=2/3(SM1)

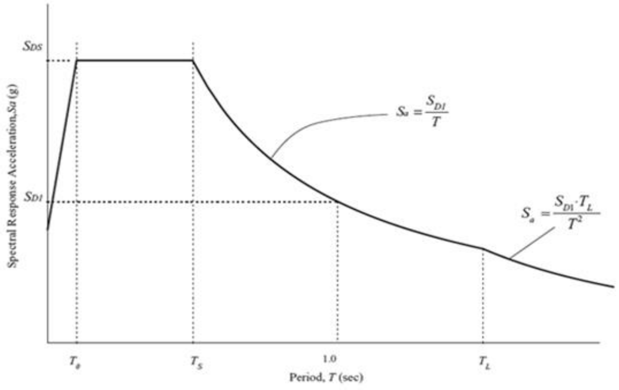
Where:

SMS = the MCER, 5 percent damped, spectral response acceleration parameter at short periods adjusted for site class effects as defined in Section 11.4.3

SM1 = the MCER, 5 percent damped, spectral response acceleration parameter at a period of 1 s adjusted for site class effects as defined in Section 11.4.3

The MCER spectral response acceleration parameter for short periods (SMS) and at 1 s (SM1), adjusted for Site Class effects, shall be determined by Eqs. 11.4-1 and 11.4-2, respectively.

Simplified design response spectrum according to ASCE 7-10



Fig”6”

Where

SDS = the design spectral response acceleration parameter at short periods
SD1 = the design spectral response acceleration parameter at 1-s period
T = the fundamental period of the structure, (s).
TL = long-period transition period, (s)

13.2.2Example:

One story building –single degree of freedom “SDOF”
Wieght =1900 kn
R=Reduction factor=3
ɣ1=Importance factor=1
Natural period=T=0.6 sec in X-direction
Seismic force Fx=(M*Sa*1)/R
M=W/g
By the same step you can calculate Fy but take T in Y-Direction
Generally Fx and Fy should > 0.85 Fxs and Fys

13.3 Egyptian code practice “ECP”

Reference : Euro code 2004

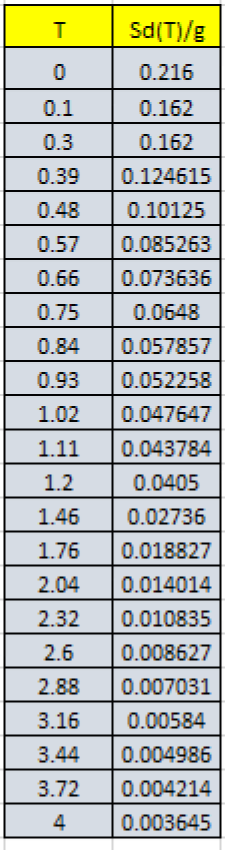
13.3.1 Manual Example

Here attached an actual example to draw spectrum response-Horizontal case

Input data				Calculations		
Response curve type		1		S	1.8	Table 8-3
Importance factor	ɣ1	D		Tc	0.3	
Building zone		3		Td	1.2	
Damping correction factor	ɳ	1		ag	1.4715	

Response modification factor	R	5		H	44	
Structure system	Ct	0.05		T1	0.8542 sec	Equation - T
Numbers of floors		12		ʎ	1	
G.F Height		4.4		Fb	1024.12	
T.F Height		3.6				
G.F Weight		16000	kn			
T.F Weight		15000				
Upper floor weight		12675				
Total weight		180000				
Li of the building		21				

Table “3”



T	Sd(T)/g
0	0.216
0.1	0.162
0.3	0.162
0.39	0.124615
0.48	0.10125
0.57	0.085263
0.66	0.073636
0.75	0.0648
0.84	0.057857
0.93	0.052258
1.02	0.047647
1.11	0.043784
1.2	0.0405
1.46	0.02736
1.76	0.018827
2.04	0.014014
2.32	0.010835
2.6	0.008627
2.88	0.007031
3.16	0.00584
3.44	0.004986
3.72	0.004214
4	0.003645

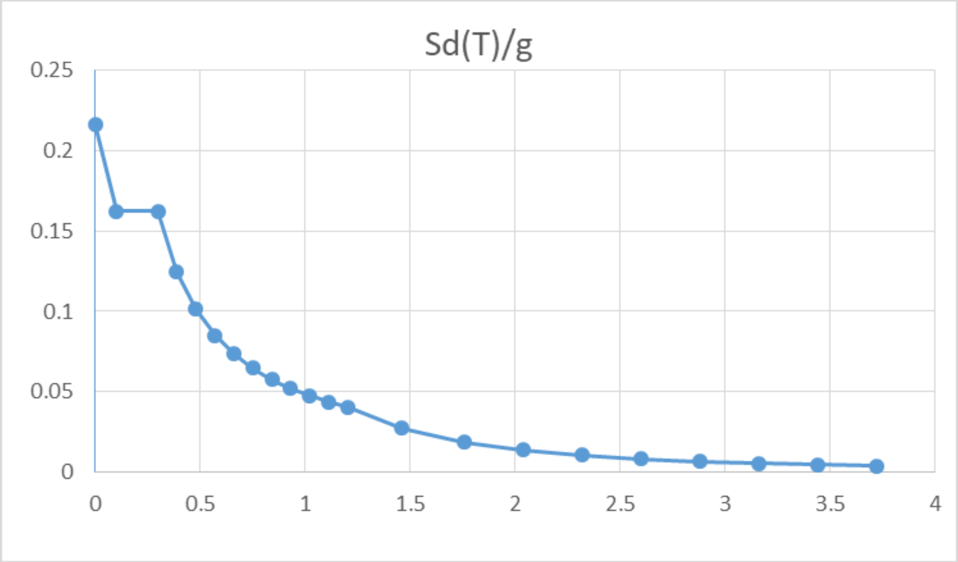


Fig “11”

Table “4”

13.3.1.1 Basic periodic time “T”

There are 3 approximate methods for calculating the basic periodic time for facilities - according to the Egyptian code, the first method is popular, with which the time calculated from the program is compared.

T1=Ct*H^3/4=0.075*(44)^3/4=0.8542 sec Equation -T

T1=The time of the fundamental wavelength of the structure in seconds

Ct =A factor that depends on the structural system and construction material

Ct = 0.075 For concrete and metal space frames with axial members that resist moments

H =The height of the structure is measured from the back of the foundations<60m

٨-٤-٢-٥ طيف التجاوب التصميمي الأفقى للتحليل الإنشائي المرن

Horizontal Design spectrum for elastic analysis

يمكن تصميم المنشأ على أحمال زلزالية تقل عما هو مقدر من طيف التجاوب المرن نتيجة لقدرة النظام الإنشائي على مقاومة قوى الزلازل في الحدود اللدنة (بعد مرحلة الليونه) .

١ - تتحدد قيمة طيف التجاوب التصميمى S_d (T) لزمن عودة قياسي بواسطة المعادلات التالية :

$$0 \le T \le T_B \quad : S_d(T) = a_g\,\gamma_I\,S\left[\frac{2}{3}+\frac{T}{T_B}\left(\frac{2.5\eta}{R}-\frac{2}{3}\right)\right], \qquad (8\text{-}11)$$

$$T_B \le T \le T_C : S_d(T) = a_g\,\gamma_I\,S\,\frac{2.5}{R}\eta, \qquad (8\text{-}12)$$

$$T_C \le T \le T_D : S_d(T) = a_g\,\gamma_I\,S\,\frac{2.5}{R}\left[\frac{T_C}{T}\right]\eta, \qquad (8\text{-}13)$$

$$\ge [0.20]\,a_g\gamma_I$$

$$T_D \le T \le 4\text{ sec} : S_d(T) = a_g\,\gamma_I\,S\,\frac{2.5}{R}\left[\frac{T_C\,T_D}{T^2}\right]\eta \qquad (8\text{-}14)$$

$$\ge [0.20]\,a_g\gamma_I$$

حيث:

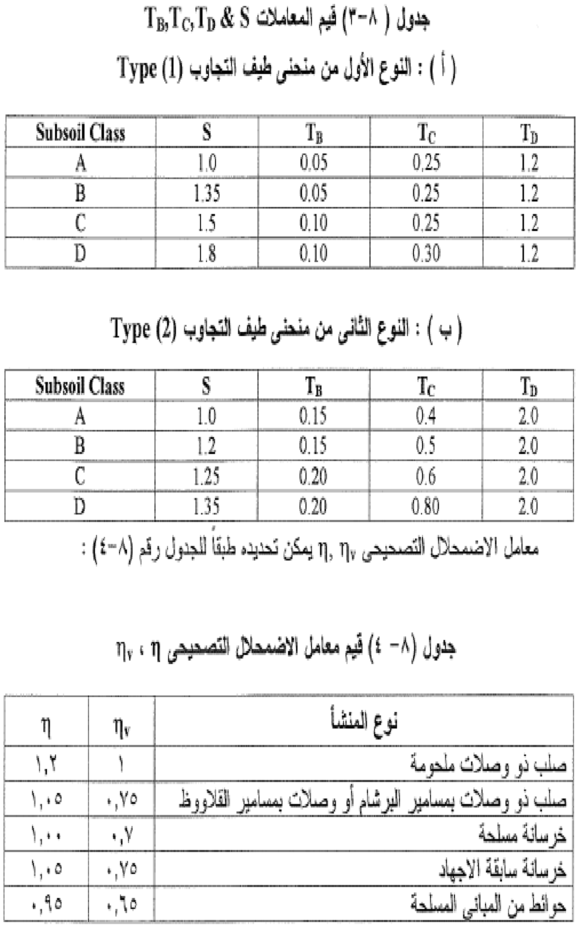
S_d (T) طيف التجاوب التصميمى للتحليل الإنشائى المرن

a_g العجلة الأرضية التصميمية لزمن عودة قياسى

γ_I معامل الأهمية للمنشأ

R معامل تعديل ردود الافعال (تخفيض القوى) تبعاً للنظام الإنشائى للمبنى (طبقاً للجدول (أ) من الملحق (أ-٨))

٢ - قيمة المعاملات S, T_C, T_D, T_B موضحة بالجدول (٨-٣).



جدول (٨-٣) قيم المعاملات T_B, T_C, T_D & S

(أ) : النوع الأول من منحنى طيف التجاوب Type (1)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.05	0.25	1.2
B	1.35	0.05	0.25	1.2
C	1.5	0.10	0.25	1.2
D	1.8	0.10	0.30	1.2

(ب) : النوع الثانى من منحنى طيف التجاوب Type (2)

Subsoil Class	S	T_B	T_C	T_D
A	1.0	0.15	0.4	2.0
B	1.2	0.15	0.5	2.0
C	1.25	0.20	0.6	2.0
D	1.35	0.20	0.80	2.0

معامل الاضمحلال التصحيحى η, η_v يمكن تحديده طبقاً للجدول رقم (٨-٤) :

جدول (٨- ٤) قيم معامل الاضمحلال التصحيحى η ، η_v

نوع المنشأ	η_v	η
صلب ذو وصلات ملحومة	١	١,٢
صلب ذو وصلات بمسامير البرشام أو وصلات بمسامير القلاووظ	٠,٧٥	١,٠٥
خرسانة مسلحة	٠,٧	١,٠٠
خرسانة سابقة الاجهاد	٠,٧٥	١,٠٥
حوائط من المباني المسلحة	٠,٦٥	٠,٩٥

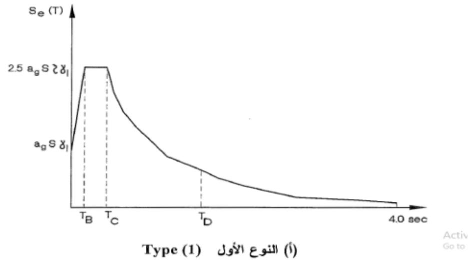
13.3.1.2 Spectrum response types :

<u>ECP used types of response spectrum</u>

13.3.1.2.1 Internal areas : Figure “11”

13.3.1.2.2 Coastal areas: Figure “12”

Kindly see response spectrum in Eurocode2004



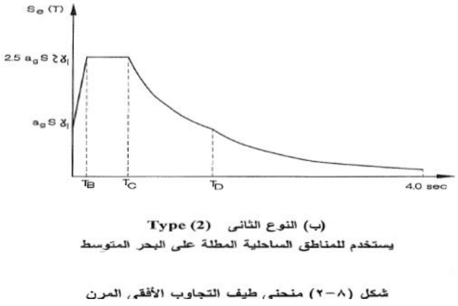


Figure “11” Figure “12”

13.3.1.3 Abbreviations-ECP

S-TB-Tc-TD see table (3-8)ECP

Sd(T): Design response spectrum for flexible structural analysis

ag : Designed gravitational acceleration for a standard period of time

1ɤ: Importance factor for the structure

R:Reaction adjustment" forces reduction “ factor according to the structural system

ɳ:Corrective decay factor values – see table (4-8)ECP

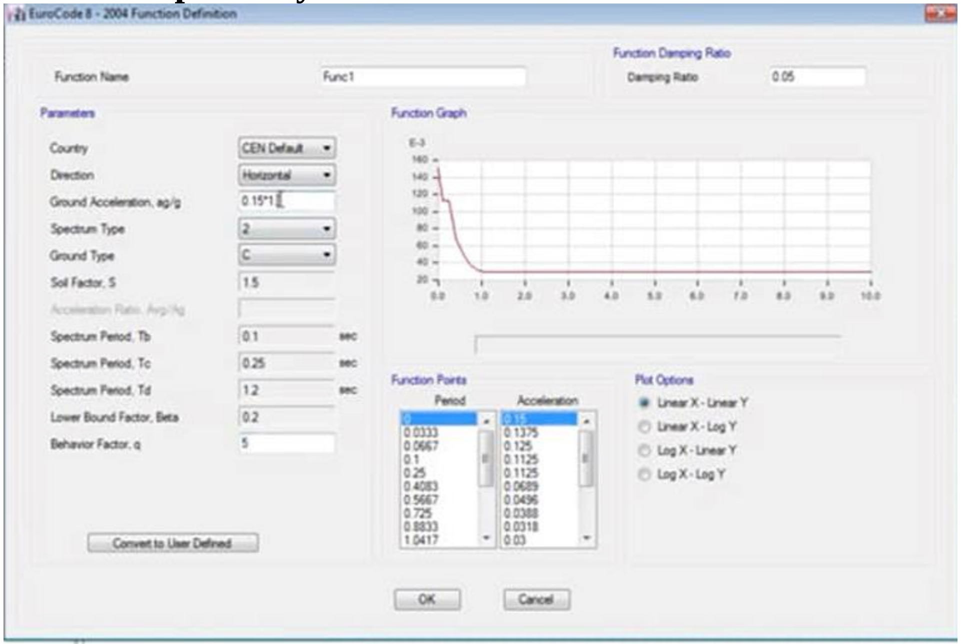
T: The periodic time of a single frequency system

S: Soil coefficient

TB , Tc :Limits of fixed values of the flexible response spectrum

TD :The value specified for the beginning of the steady movement of the spectrum

13.3.2 Spectrum response by Etabs



Function Name: Func1

Function Damping Ratio

Damping Ratio: 0.05

Parameters

Country: CEN Default

Direction: Horizontal

Ground Acceleration, ag/g: 0.15*1

Spectrum Type: 2

Ground Type: C

Soil Factor, S: 1.5

Acceleration Ratio, Avg/Ag:

Spectrum Period, Tb: 0.1 sec

Spectrum Period, Tc: 0.25 sec

Spectrum Period, Td: 1.2 sec

Lower Bound Factor, Beta: 0.2

Behavior Factor, q: 5

Function Points

Period	Acceleration
0	0.15
0.0333	0.1375
0.0667	0.125
0.1	0.1125
0.25	0.1125
0.4083	0.0689
0.5667	0.0496
0.725	0.0388
0.8833	0.0318
1.0417	0.03

Plot Options

● Linear X - Linear Y
○ Linear X - Log Y
○ Log X - Linear Y
○ Log X - Log Y

13.3.2.1.1 After initial steps As Mas source

13.3.2.1.2 Put spectrum response

By using Etabs -Function –response
The above screen appeared
Choose linear X-y for horizontal case
Code : Euro code2004
Name : use name as FUNC1
ag : table 2b-32, page119 ECP
Zone : 3 for Cairo
Spectrum No : 1
Ground type: type A,B,C or D as mentioned in soil report
Tb-Tc-Td and S : From table 8-3 ECP
Behavior factor : Reduction factor deepened on structure type and ductility –in case of limited ductility R=5
Importance factor : from table 8-9 page 149 ECP
Ground acceleration: Importance factor *ag
Damping rates =0.05

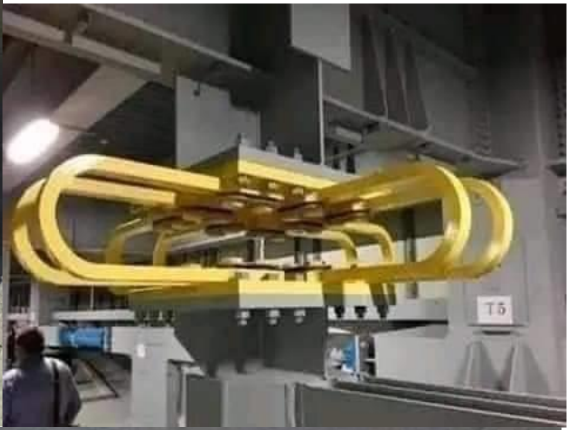
13.3.2.1.3 Complete other steps for EQ loading

13.3.2.1.4 Checks

mass and Rigidity eccentricity
Percentages of dynamic and static loads
Time period calculated

14 Earthquake dampers

Specialists sometimes resort to using earthquake dampers to reduce their effects on structures, after making sufficient design calculations to determine the characteristics, geometric dimensions, and capabilities of the dampers.


T5

15 Recommendations

Choosing the spectrum response according to the design code, which depends on the seismic area and the nature of the soil, and dealing with it through the data stipulated about it, such as Limits of fixed values of the flexible response spectrum, and Soil parameters are the practical approach to introducing earthquake loads on structures correctly, which subsequently reduces the impact of earthquakes to the extent that allows the building to be used safely.

This requires understanding the nature of the spectrum response curve and the philosophy of its composition in cases of manual solution or related computer applications ,as well as the properties of the materials and the structural system used.

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