1) **IS 1893-2002** P-Cube Consultants

Design Acceleration spectrum = Z/2*I/R*Sa/g ..... cl 6.4

where I = 1
Z= 0.16
R= 5 SMRF
T= 1 sec
Soil Medium type
sa/g = 1.36

Ah = 0.02176

2) **IS 1893-2016**

Design Acceleration spectrum = Z/2*I/R*Sa/g ..... cl 6.4

where I = 1.2 for more than 200 people occupancy
Z= 0.16
R= 5 SMRF
T= 1 sec
Soil Medium type
sa/g = 1.36

Ah = 0.026112

3) **IS 1893 Draft 2023**

Design Acceleration spectrum = Z*I*Anh(T)/R

where I = 1 Building set-2
Z= 0.2 975 Return periods more than 200 person
R= 5 SMRF
T= 1 sec
Soil Site Class C where
here Vs = Ehi/E(hi/vsi) (Isolated footing)
vsi = 80 (Ni)^0.5 Cohessionless
vs1= 438.178 vs2= 438.17805 vs3= 473.2864
N value approx. 30 for two layer of 300mm and 35 for one layer 300mm
Vs = 449.2874 m/s
Anh = 1.5
Anh (T) = 1.5 for 5% damping
Ah (T) = Z*I*Anh(T)
Ah (T) = 0.3
Ahs(T) = 0.06

4) **NZS 1170.5:2004** Newzeland

Elastic site spectrum horizontal loading C(T)=Ch(T)*Z*R*N(T,D)
Design Acceleration spectrum Cd(T)= C(T)*Sp/ku

Ch(T)=	1.19	for T=1 and shallow soil Velocity more than 300
Z=	0.16	Hamilton to wellington more than 300km
		(like Ahmedabad to Bhuj)
R=	1.3	Return period factor 1000 year
T=	1	sec
N(T,D) =	1	annual probability >1/250

C(T) =	0.24752	
Here Sp=	0.7	
Ku=	3	SLD (Structure limited ductility) = 1.25 to 3
Ku=	6	DS (Ductile system) =1.25 to 6 (max ductile material or any system)

Cd(T)=	0.057755	SLD
Cd(T)=	0.028877	DS
Min Cd(T) =	(Z/20+0.02)R	but min 0.03R
Min Cd(T) =	0.0364	but min 0.039

SLD Cd(T) = 0.057755
DS Cd(T) = 0.039

5) **ASCE 7-16** U.S.

Seismic Response coefficient Cs= Sds/(R/I)

where I =	1.25	Category 3 of important structure
R=	5	B type line4 Special Reinforce concrete shear wall
T=	1	sec

Sds = 2/3*Sms
Sms=Fa*Ss
Sdl = 2/3*Sml
Sml=Fv*Sl

	Class C	366m/s to 446 m/s
	22-1,22-2	Los angles to 300km or Memphis to 300km
Fa=	1.2	Table 11.4.1
Fv=	1.5	Table 11.4.2
Ss =	0.3	Memphis to 300km
Sl=	0.15	Memphis to 300km
Sds =	0.24	
Sdl=	0.15	
TL=	12	
T<TL	Cs= Sdi/T*I/R =	0.0375

Cs= 0.06 minimum Cs =0.044*Sds*I but min. 0.01

min. Cs = 0.0132

if SI > 0.6 Cs=0.5SI/(R/I)

Cs= 0.01875

Cs for 0.2 sec 0.06

Cs for 1 sec 0.0375

6) EUROCODE 8-2004 Singapore

Horizontal Base shear Fb = Sd(T)*W*y

Ground Type Class C for N value 15 to 50 No.

According to Table 3.2 & 3.3

	TYP-1	TYP-2
S=	1.15	1.5
Tb=	0.2	0.1
Tc=	0.6	0.25
Td=	2	1.2

T= 1 sec

Tc<T<Td

Sd(T)= ag*S*2.5/q*(TC/T)

> Beta*ag

qo= 4.5 for DCH System

q= qo*(alphau/alpha1)*kw

(alphau/alpha1) 1.3 multi storied & multi bays

q= 5.85

gamma= 1

ag= gamma*agR

	Ag	Sd(T) (Ty-1	Sd(T) (Ty-2)
Singapore 475 return period single zone	0.175	0.052	0.028
Germany 975 year Stuttgart to 220km away Nuremburg	0.312	0.092	0.050

Comparisons Table

	Different codes							Singapore
	IS 1893-2002 (After Bhuj EQ)	IS 1893-2016	IS 1893-2023 Draft	NZS 1170.5:2004		ASCE 7-16		Eurocode 8
				SLD	DS	Short T	Long T	
Ah or cd or cs	0.0218	0.0261	0.0600	0.0578	0.0390	0.0600	0.0375	0.052
Diff to IS 1893-2002	1.00	1.20	2.76	2.65	1.79	2.76	1.72	2.37
EQ Load factor	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00
Diff to IS 1893-2002	**1.00**	**1.20**	**1.84**	**1.77**	**1.19**	**1.84**	**1.15**	**1.58**

****This all data only for understanding and information purpose

Design Earthquake Zone Factor Z

Earthquake Zone		Zone-2	Zone-3	Zone-4	Zone-5	Zone-6
for different Return Periods TRP (years)	73	0.0375	0.075	0.18	0.24	0.3
	225	0.05	0.1	0.225	0.3	0.375
	475	0.075	0.15	0.3	0.4	0.5
	975	0.1	0.2	0.36	0.48	0.6
	2,475	0.15	0.3	0.45	0.6	0.75
	4,975	0.2	0.4	0.54	0.75	0.9375
	9,975	0.25	0.5	0.675	0.9	1.125

During Bhuj 2001 Earthquake PGA in Ahmedabad at various site is 0.1g to 0.11g (in 0.005 sec time step)

1

PGA (max) single direction	PGA (Max) (vector sum h1, h2,v)	Magnitude	Depth	Earthquake
3.23 g		7.8	15 km	2016 Kaikoura earthquake
2.7 g	2.99 g	9.1	30 km	2011 Tohoku earthquake and tsunami
	4.36 g	6.9	8 km	2008 Iwate–Miyagi Nairiku earthquake
1.92 g		7.7	8 km	1999 Jiji earthquake
1.82 g		6.7	18 km	1994 Northridge earthquake
1.81 g		9.5	33 km	1960 Valdivia earthquake
1.62 g		7.8	10 km	2023 Turkey–Syria earthquake
1.51 g		6.2	5 km	2011 Christchurch earthquake
1.26 g		7.1	10 km	2010 Canterbury earthquake
1.25 g		6.6	8.4 km	1971 Sylmar earthquake
1.04 g		6.6	10 km	2007 Chuetsu offshore earthquake
0.98 g		7	16.1 km	2020 Aegean Sea earthquake
0.91 g		6.9	17.6 km	1995 Great Hanshin earthquake
0.8 g		7.2	12 km	2013 Bohol earthquake
0.65g		6.9	19 km	1989 Loma Prieta earthquake
0.5 g		7	13 km	2010 Haiti earthquake
0.34 g		6.4	15 km	2006 Yogyakarta earthquake
0.18 g		9.2	25 km	1964 Alaska earthquake