VIBRATION STANDARDS FOR DIFFERENT COUNTRIES/RESEARCHERS

1. **DGMS prescribed permissible limit of ground vibration (INDIA)**

Type of structures	Dominant excitation frequency, Hz		
	< 8Hz	8-25Hz	>25Hz
(A) Buildings/structures not belong to the owner			
1. Domestic houses/structures (Kuchcha, bricks & Cement)	5	10	15
2. Industrial building	10	20	25
3. Objects of historical importance & sensitive Structures	2	5	10
(B) Buildings belonging to the owner with limited span of life			
1. Domestic houses/structures	10	15	20
2. Industrial buildings	15	25	50

2. After Indian Standard Institution (1973)

Soil, weathered or soft conditions	70 mm/s
Hard rock conditions	100 mm/s

3. After CMRI Standard (Dhar et al, 1993)

Type of structures	PPV(mm/s)	
	<24 Hz	>24 Hz
Domestic houses, dry well interior, construction Structures with plasters, bridge	5.0	10.0
Industrial buildings, steel or reinforced concrete structures	12.5	25.5
Object of historical importance, very sensitive Structures, more than 50 years old construction and Structures in poor state condition	2.0	5.0

4. After Australian Standard (As A-2183) (Just and Chitombo,1987)

Type of structures	Ground ppv (mm/s
Historical building and monuments and buildings of special value	2
Houses and low rise residential buildings, commercial buildings not Included below	10
Commercial buildings and industrial buildings or structures of reinforced Concrete or steel construction	25

5. After Australian Standard (Ca-23-2183) (Just and Chitombo,1987)

Types of structures	Ground ppv (mm/s)
Historical buildings and monuments and buildings of Special value	0.2 mm displacement for frequencies less than 15 Hz
Houses and low rise residential buildings, commercial Buildings not included below	19 mm/s resultant PPV for frequencies greater than 15 Hz
Commercial buildings and industrial buildings or Structures of reinforced concrete or steel construction	0.2 mm maximum displacement correspond to 12.5 mm/s PPV at 10 Hz and 6.25 mm/s at 5 Hz

6. After Hungarian Standard

Type of structures	Permissible limit (mm/s)
Construction demanding special protection, military, telephones, Airport, dams, bridges which have length of more then 20 m	Extra opinion from expert
Statistically not solid damaged construction, temples, monuments, Oil and gas wells and upto 0.17 Mpa and below 0.7 Mpa pressure In pipes (oil and gas)	2
Panel houses and statistically not fully determined structures	5
Statistically good condition structures, towers, electrical apparatus, water plant	10
RCC and structures concrete, tunnels, canals and other pipe lines Beneath the soil surface greater than 0.7m, opening the sublevel	20
Public road, railway and electrical lines, telephone lines ropeway	50

7. After USSR Standard

Type of structures	Allowable PPV (mm/s)	
	Repeated	One fold
Hospitals	8	30
Large panel residential buildings and children,s institution	15	30
Residential and public buildings of all type except large panels, Office and industrial buildings having deformations, boiler rooms And high brick chimneys	30	60
Office and industrial buildings, high reinforced concrete pipes, Railway and water tunnels, traffic flyovers, saturated sandy slopes	60	120
Single storage skeleton type industrial buildings, metal and block Reinforced concrete structures, soil slopes which are part primary Structures, primary mine openings(service life upto 10 years) pit bottom, main entries, drifts	120	240
Secondary mine openings (service life upto 3 years) haulages and drifts	240	480

8. After Swiss Standard

Type of structures	Frequency Band width [Hz]	Blast induced PPV [mm/s]	Traffic/machine induced PPV [mm/s]
Steel or reinforced structures such as factories, retaining walls, bridges, steel towers, open channels, underground tunnels and chambers	10-60	30	-
	60-90	30-40	-
	10-30	-	12
	30-60	-	12-18
Buildings with foundation walls and floor in concrete, well in concrete or masonry, underground chambers and tunnels with masonry linings	10-60	18	-
	60-90	18-25	-
	10-30	-	8
	30-60	-	8-12
Building with masonry walls and wooden ceilings	10-60	12	-
	60-90	12-18	-
	10-30	-	5
	30-60	-	5-8
Objects of historic interest or other sensitive structures	10-60	8	-
	60-90	8-12	-
	10-30	-	3

9. After Siskind et al., 1980

Type of structures	PPV (mm/s)	
	Frequency (< 40 Hz)	Frequency (> 40 Hz)
Modern homes, dry wall interior	18.75	50
Older homes, plaster on wood lath construction	12.5	50

10. After Sweden Standard (after Pesson et al., 1980)

Type of Structures	Limiting vibration parameters		
	Amplitude (mm)	Velocity (mm/s)	Acceleration (mm/s^2)
Concrete bunker steel-reinforced	-	200	-
High rise apartment block-modern concrete of steel frame design	0.4	100	-
Underground rock cavern roof hard rock, span 15-18 m	-	70-100	-
Normal block of flat-brick or equivalent walls	-	70	-
Light concrete buildings	-	35	-
Swedish National Museums-Building structures	-	25	-
Swedish National Museums-Sensitive exhibits	-	-	5
Computer centre	0.1	-	2.5
Circuit breaker control room	-	-	0.5-2.0

11.Blast damage criteria for mass concrete (Tennessee Valley Authority and Distance factor given by Oriard,2002)

Concrete age from Batching	Allowable Particle velocity In/s (mm/s)	Definition of Distance Factor		
		Distance Factor	Distance From Blast	
			(ft)	(m)
0-4 hrs.	4 (100) x D.F.	-		
4 hrs. – 1 day	6 (150) x D.F.	1.0	0-50	0-15
1 to 3 days	9 (225) x D.F.	0.8	50-150	15-46
3 to 7 days	12 (300) x D.F.	0.7	150-250	46-76
7 to 10 days	5 (375) x D.F.	0.6	250 +	76 +
10 days or more	20 (500) x D.F.	-		

12. After German DIN Standard 4150 (1986)

Type of Structures	Peak particle velocity (mm/s) at foundation		
	< 10 Hz	10-50 Hz	50-100 Hz
Offices and industrial premises	20	20-40	40-50
Domestic houses and similar constructions	5	5-15	15-20
Buildings that do not come under the above because of their sensitivity	3	3-8	8-10

13. Summary of residential criteria (After Oriard, 2002)

RANGE OF COMMON RESIDENTAL CRITERIA AND EFFECTS	
0.5 in/s (12.7 mm/s)	Bureau of mines recommended guideline for plaster-on-lath construction near surface (long-term, large-scale blasting operations, low frequency vibrations) RI-8507
0.75 in/s (19.1mm/s)	Bureau of mines recommended guideline for sheet rock construction near surface mines. (RI-8507)
1.0 in/s (25.4mm/s)	OMS regulatory limits fir residences near surface mine operations at distances of 301-5000ft. (long-term, large-scale blasting)
2.0 in/s (50.8 mm/s)	Widely accepted limit for residences near construction blasting and quarry blasting.(Bu Min Bulletin 656, RI 8507, various codes, specifications and regulations). Also allowed by OSM for frequencies above 30Hz.
5.4 in/s (137.0 mm/s)	Minor damage to the average house subjected to quarry blasting vibrations. (Bu Min Bulletin 656).
5.4 in/s (229.0 mm/s)	About 90% probability of minor damage from construction or quarrying blasting. Structural damages to some houses. Depends on vibration sources, character of the vibrations and the house.
20 in/s (500.8 mm/s)	For closed-in construction blasting, minor damage to nearly all houses, structural damage to some. A few may escape damage entirely. For low-frequency vibrations, major damage to most houses.
Note: The criteria shown in this table apply only to residences, not to any other structures, facilities or materials.	

14. After Langefors et al. (1958)

No damage	<50 mm/s
Fine cracking	100 mm/s
Cracks	150 mm/s
Serious crack	225 mm/s

15. After Edwards and Northwood (1960)

Safe zone	<50 mm/s
Damage zone	100-150mm/s

16. After Duval and Fogelson (1962)

Major damage (95%)	50 mm/s

17. After Nichols et al. (1971)

Safe zone (95%)	<50 mm/s
Danger zone	> 50 mm/s

18. Ground Vibration Effects Summary (David Siskind, 2000: Vibration from Blasting International Society of Explosives Engineers)

PPV (in/s)	PPV (mm/s)	Vibration Effects
0.001	0.0254	Quiet background
0.01	0.254	Threshold of human perception for steady-state Vibration (physical)
0.03	0.762	Traffic at 50 ft (16 m)
0.03	0.762	Noticeable houses rattling and response from vibration
0.06	1.524	Threshold of human perception for transient vibration (physical)
0.10	2.54	Truck traffic on bumpy road at 50 feet (16 m)
0.18-0.32	4.572-8.128	Train at 20 feet
0.30	7.62	Pavement breaker at 30 feet
0.50	12.70	Lowest threshold for plaster creak extension in house
0.50	12.70	Lowest USBM safe vibration criteria (USBM RI-8507, for low frequencies)
0.50	12.70	Typical household environment from inside activities and natural forces of wind, temperature and humidity
0.70	17.78	ANSI limit for human comfort: steady state vibration (S-3.18-1979)
0.75	19.05	Strictest federal to protect homes from cosmetic cracking from surface coal mine blasts (OSM, for distances >5,000ft)
0.79	20.066	Lowest level for an observed crack extension in wallboard (RI8507)
1.00	25.40	Federal limit to protect homes from cosmetic cracking from surface coal mine blasts (OMS, for distances of 301 to 5,000ft)
1.20	30.48	Response of house superstructure from 62-mph wind (BOCAcode, 10 psf)
1.25	31.75	Federal limit to protect homes from cosmetic cracking from surface coal mine blasts (OMS, for distance < 300 ft)
2.00	50.80	USBM recommendation for safe blasting from 1962 and 1971 (RI 5968 and B 656)
2.00	50.80	Most state,s limit for protecting homes from blasting
2.00	50.80	Safe-level criteria for cosmetic cracking in homes from high-frequency blasts, such as construction (USBM RI 8507)
2.00	50.80	ANSI limit for human health: Steady state vibration (S-3.18-1979)
2.00	50.80	Highest vibrations generated inside homes by walking, jumping , slamming doors, etc.
4.00	101.6	ANSI limit for human health: steady-state vibration (S-3. 18)
5.00	127.0	Vibration tolerance for buried utilities including wells and pipelines
5.00	127.0	Lowest vibration for masonry vibration cracking from blasting

10.0	254.0	Threshold for cracking of mass concrete
12.0	304.8	Damage threshold for underground works

19. After Rosenthal and Morlock (1983)

Distance from blasting site [m]	Maximum allowable ppv [mm/s]
0 to 91.4	37.75
91.4 to 1524.0	25.40
1524 and above	19.05

AIR OVERPRESSURES STANDARDS AND LIMIT

1. typical overpressure criteria (After Oriard, 2002)

1.0 psi (171 dB)	General window breakage
0.1 psi (151 dB)	Occasional window breakage
0.029 psi (140 dB)	Long-term history of application for as a safe project specifications
0.0145 psi (134 dB)	Bureau of mines recommendation following a study of large-scale surface mine blasting

2. Overpressure limit recommended by USBM for surface mining (RI 8485)

134 dB	0.1 Hz high pass measuring system
133 dB	2.0 Hz high pass measuring system
129 dB	6.0 Hz high pass measuring system
105 dB	C-slow weighting scale on a sound level meter
(events less than or equal to 2-sec duration)	