भारतीय मानक

निलम्बन वाले पुलों के लिए तार के रस्से और लड़ें — विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

WIRE ROPES AND STRANDS FOR SUSPENSION BRIDGES — SPECIFICATION

(First Revision)

ICS 77.140.65:93.040

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 5

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wire Ropes and Wire Products Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1979. This standard was prepared since the absence of such a standard was long felt by designers and engineers for erection of suspension bridges either for pedestrian, vehicular or other use. The wire ropes and strands covered in the standard are suitable for stiffened as well as unstiffened suspension bridges. This standard was prepared in consultation with the leading manufacturers and important users.

In this first revision, based on the experience gained in the industry, construction details, modulus of elasticity and certain other requirements have been modified. Requirement of lubrication is also added.

The composition of the Committee responsible for the formulation of this standard is given in Annex B

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

WIRE ROPES AND STRANDS FOR SUSPENSION BRIDGES — SPECIFICATION

(First Revision)

1 SCOPE

This standard covers requirements for wire ropes and strands for use in suspension bridges for pedestrian, vehicular traffic pipe crossing and other applications. The following types, constructions, rope/strand grades and size ranges are covered (identified by X mark).

3 TERMINOLOGY

For the purpose of this standard, the terms and definitions given in IS 2363 shall apply.

4 MATERIAL

4.1 All the wires used in the manufacture of ropes and strands shall comply with the requirements laid down in IS 1835. In case of locked coil wire ropes, the shaped wires shall conform to the requirements of dimension and tensile test only.

Type	*Construction*	*Rope/Strand Grade*		*Core*	*Size Range* (mm)	*Table No.*
		1 420	1 570			
Round Strand	a) 7×7 (6-1)	X	X	Steel	12-32	1
	b) 7×19 M (12/6-1)	X	X	Steel	23-48	2
	c) 7×37 M (18/12/6-1)	X	X	Steel	38-64	3
Spiral Strand	a) 1×7 (6-1)	X	X	Steel	6-15	4
	b) 1×19 J (12:6-1)	X	X	Steel	12-25	5
	c) 1×37 J (18:12:6-1)	X	X	Steel	20-35	6
	d) 1×61 J (24:18:12:6-1)	—	X	Steel	26-45	7
	e) 1×91 J (30:24:18:12:6-1)	—	X	Steel	33-56	8
	f) 1×91 J (30:24:18:12-6F-6-1)	—	X	Steel	33-56	8
	g) 1×127 J(36:30:24:18:12:6-1)	—	X	Steel	40-65	9
	h) 1×169 J(42:36:30:24:18:12:6-1)	—	X	Steel	40-65	10
Half and Full Locked Coil Wire Rope	—	1 370		—	26-80	11
		1 470		—	26-80	11

4.2 Requirements of Wire

4.2.1 *Dimensional Limits and Tolerances*

The wire size tolerance shall be in accordance with IS 1835 as applicable for galvanized wire 'Type A'. The dimensions of shaped wires in case of locked coil wire ropes shall be provided at the discretion of the manufacturer.

4.2.2 *Tensile Test*

For stranded rope and spiral strand the tensile designation of individual wires shall be chosen as recommended in IS 6594. In case of locked coil wire ropes use of wires of different tensile designations is permitted but the combined tensile strength shall not

2 REFERENCES

The following Indian Standards contain provisions, which through reference in this text constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1608 : 1995	Mechanical testing of metals — Tensile testing (*second revision*)
1835 : 1976	Round steel wire for ropes (*third revision*)
2363 : 1981	Glossary of terms relating to wire ropes (*first revision*)
6594 : 2001	Technical supply conditions for steel wire ropes (*second revision*)

fall below 1 370 or 1 470 as applicable shown in the Table 11. Manufacturer shall provide tensile designation of all wires used in the locked coil wire ropes.

NOTE — In general the shaped wires shall be of lower tensile designation whereas the round wires shall be of higher tensile designation.

4.2.3 The tensile strength shall be checked in accordance with IS 1608 and shall meet the requirement of IS 1835.

4.3 Elongation Test

The wire shall have an elongation not less than 4 percent of a gauge length equivalent to '100 × diameter of wire'.

4.4 Proof Stress

When subjected to 0.2 percent proof stress test the wire shall show a force equivalent to atleast 70 percent of the breaking force of the wire.

4.5 Galvanizing

4.5.1 All wires shall be galvanized. The galvanizing shall be carried out either by the hot dip or electrical process to provide a continuous, uniform coating of zinc of purity not less than 98 percent. The zinc coating shall be of 'Type A' according to IS 1835 for round wires. For shaped wires the mass of zinc coating shall not be less than 45 g/m^2.

4.5.2 *Wrap Test*

The wire shall not show any fracture when wrapped at a rate not exceeding 15 turns per minute in a close helix for at least 2 turns around a cylindrical mandrel 4 times in diameter of the wire to be tested for wires of tensile strength 1 570 N/mm^2 and 3 times the diameter of the wire to be tested in case of lower tensile strength.

5 GENERAL REQUIREMENTS

General requirements shall be according to IS 6594.

6 JOINTS

6.1 In case of stranded and locked coil ropes, joint in wires shall be avoided as far as possible except where they are necessitated by the length of the rope. The joints in the wires of the strand shall be distributed as widely as possible and in no case shall more than one wire be joined in any length of 10 m of strand in case of a stranded rope and 10 m of rope length in case of locked coil wire ropes.

6.2 Joints shall be either brazed or electrically welded. If joints are brazed they shall be properly scarfed or if welded properly annealed. Tucked joints shall not be used.

7 DIRECTION OF LAY

7.1 Unless otherwise stated, the locked coil wire ropes and spiral strands shall be of right hand lay (*z*), and round strand wire ropes shall be of right hand ordinary lay (*sZ*).

7.2 Stranded ropes shall be of ordinary lay (*sZ* or *zS*).

7.3 Spiral strands and locked coil ropes shall be so constructed that the wires in successive layers are alternatively laid. However, in case of locked coil wire ropes, the outer layers may be laid in one direction and all the inner layers in the opposite direction.

8 LENGTH OF LAY

8.1 The length of lay for stranded ropes shall not exceed 8 times the nominal diameter of the rope.

8.2 The length of lay for spiral strands shall not exceed 15 times the nominal diameter of the strand.

8.3 The length of lay for locked coil wire ropes shall not exceed 15 times the nominal diameter of the locked coil wire rope.

9 LUBRICATION

The wire ropes/strands and the locked coil wire ropes shall be lubricated or not lubricated as per the requirement of the purchaser.

10 MINIMUM BREAKING FORCE

The minimum breaking force of wire ropes shall be as given in Tables 1 to 11.

11 ELONGATION OR STRETCH OF WIRE ROPE

For elongation or stretch of wire ropes, *see* Annex A.

12 MARKING

12.1 The size, construction, rope grade, lay, core, coating and length of wire rope, reel/coil number along with the order number of purchaser and any other marking which may be specified by the purchaser shall be legibly mentioned on a suitable tag securely attached, when wire ropes are supplied in coils. In case wire ropes are supplied in reels, the information may be stenciled on both sides of the reels or stenciled on one side of the reel and a suitable tag giving the same information may be attached on the other side of the reel.

12.2 BIS Certification Marking

12.2.1 The product may be marked with the Standard Mark.

12.2.2 The use of the Standard Mark is governed by

the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of Standard Mark may be granted to the manufacturers or producers may be obtained from the Bureau of Indian Standards.

13 PACKING

The rope shall be suitably protected to avoid damage in transit and corrosion. Ropes of ordinary lay may be supplied in coils or reels as required by the purchaser.

NOTE — Lang's lay ropes and multi strand rotation-resistant ropes should preferably be supplied on reels unless specified otherwise.

Table 1 Round Strand 7 × 7 (6-1) Construction Wire Rope
(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Rope Grade of	
		1 420	1 570
(1)	(2)	(3)	(4)
		kN	kN
12	56.6	73	81
13	66.4	86	95
14	77.0	100	110
15	88.4	115	127
16	101	130	144
17	114	147	163
18	127	165	183
19	142	184	203
20	157	204	225
21	173	225	248
22	190	247	273
23	208	270	298
24	226	293	324
25	246	318	352
26	266	344	381
27	287	371	411
28	308	399	442
29	331	428	474
30	354	459	507
31	378	490	541
32	403	522	577

NOTES

1 To calculate the aggregate breaking force multiply the values given in columns 3 and 4 by 1.194.

2 The values for masses are for guidance only.

Table 2 Round Strand 7 × 19 M (12/6-1) Construction Wire Rope
(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Rope Grade of	
		1 420	1 570
(1)	(2)	(3)	(4)
		kN	kN
23	201	249	276
24	219	271	300
25	238	295	326
26	257	319	352
27	277	344	380
28	298	369	409
29	320	396	438
30	343	424	469
31	366	453	501
32	390	483	534
33	414	513	567
34	440	545	602
35	466	577	638
36	493	611	675
37	521	645	713
38	550	681	752
39	579	717	793
40	609	754	834
41	640	792	876
42	671	831	919
43	704	871	963
44	737	912	1 009
45	771	954	1 055
46	805	997	1 103
47	841	1 041	1 151
48	877	1 086	1 201

NOTES

1 To calculate the aggregate breaking force multiply the values given in columns 3 and 4 by 1.25.

2 The values for masses are for guidance only.

Table 3 Round Strand 7 × 37 M (18/12/6-1) Construction Wire Rope

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Rope Grade of	
		1 420	1 570
(1)	(2)	(3)	(4)
		kN	kN
38	550	653	722
39	579	688	760
40	609	723	800
41	640	760	840
42	671	798	882
43	704	836	924
44	737	875	968
45	771	916	1 012
46	805	957	1 058
47	841	999	1 104
48	877	1 042	1 152
49	914	1 086	1 200
50	952	1 130	1 250
51	990	1 176	1 300
52	1 029	1 223	1 352
53	1 069	1 270	1 404
54	1 110	1 318	1 458
55	1 151	1 368	1 512
56	1 194	1 418	1 568
57	1 237	1 469	1 624
58	1 280	1 521	1 682
59	1 325	1 574	1 740
60	1 370	1 628	1 800
61	1 416	1 682	1 860
62	1 463	1 738	1 922
63	1 511	1 794	1 984
64	1 559	1 852	2 048

NOTES

1 To calculate the aggregate breaking force multiply the values given in columns 3 and 4 by 1.302.

2 The values for masses are for guidance only.

Table 4 Spiral Strand 1 × 7 (6-1) Construction Wire Rope

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Strand Grade of	
		1 420	1 570
(1)	(2)	(3)	(4)
		kN	kN
6	18.1	28	31
7	24.6	38	42
8	32.1	49	55
9	40.7	63	69
10	50.2	77	85
11	60.7	94	103
12	72.3	111	123
13	84.8	131	144
14	98.4	151	167
15	113	174	192

NOTES

1 To calculate the aggregate breaking force multiply the values given in columns 3 and 4 by 1.111.

2 The values for masses are for guidance only.

Table 5 Spiral Strand 1 × 19 J (12 : 6-1) Construction

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Strand Grade of	
		1 420	1 570
(1)	(2)	(3)	(4)
		kN	kN
12	71	107	119
13	84	126	139
14	97	146	162
15	111	168	186
16	127	191	211
17	143	216	238
18	161	242	267
19	179	269	298
20	198	298	330
21	218	329	364
22	240	361	399
23	262	395	436
24	285	430	475
25	310	466	515

NOTES

1 To calculate the aggregate breaking force multiply the values given in columns 3 and 4 by 1.136.

2 The values for masses are for guidance only.

Table 6 Spiral Strand 1 × 37 J (18 : 12 : 6-1) Construction

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Strand Grade of	
		1 420	1 570
(1)	(2)	(3)	(4)
		kN	kN
20	196	294	326
21	216	325	359
22	237	356	394
23	259	389	431
24	282	424	469
25	306	460	509
26	330	498	550
27	356	537	593
28	383	577	638
29	411	619	684
30	440	663	732
31	470	707	782
32	501	754	833
33	532	802	886
34	565	851	941
35	599	902	997

NOTES

1 To calculate the aggregate breaking force multiply the values given in columns 3 and 4 by 1.136.

2 The values for masses are for guidance only.

Table 7 Spiral Strand 1 × 61 J (24:18:12:6-1) Construction

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Strand Grade of 1 570
(1)	(2)	(3)
		kN
26	327	544
27	352	586
28	379	630
29	406	676
30	435	724
31	464	773
32	495	823
33	526	876
34	558	929
35	592	985
36	626	1 042
37	661	1 101
38	697	1 161
39	735	1 223
40	773	1 286
41	812	1 352
42	852	1 418
43	893	1 487
44	935	1 557
45	978	1 628

NOTES

1 To calculate the aggregate breaking force multiply the values given in column 3 by 1.136.

2 The values for masses are for guidance only.

Table 8 Sprial Strand 1 × 91 J (30:24:18:12:6–1) (30:24:18:12-6F-6-1) Construction

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Strand Grade of 1 570
(1)	(2)	(3)
		kN
33	525	873
34	557	927
35	590	982
36	624	1 039
37	659	1 098
38	696	1 158
39	733	1 220
40	771	1 283
41	810	1 348
42	850	1 415
43	891	1 483
44	933	1 553
45	975	1 624
46	1 019	1 697
47	1 064	1 772
48	1 110	1 848
49	1 157	1 925
50	1 204	2 005
51	1 253	2 086
52	1 303	2 168
53	1 353	2 253
54	1 405	2 339
55	1 457	2 426
56	1 511	2 515

NOTES

1 To calculate the aggregate breaking force multiply the values given in column 3 by 1.136.

2 The values for masses are for guidance only.

Table 9 Sprial Strand 1 × 127 J (36:30:24:18:12:6-1) Construction

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Rope Grade of 1 570
(1)	(2)	(3)
		kN
40	771	1 283
41	810	1 348
42	850	1 415
43	891	1 483
44	933	1 553
45	975	1 624
46	1 019	1 697
47	1 064	1 772
48	1 110	1 848
49	1 157	1 925
50	1 204	2 005
51	1 253	2 086
52	1 303	2 168
53	1 353	2 253
54	1 405	2 339
55	1 457	2 426
56	1 511	2 515
57	1 565	2 606
58	1 620	2 698
59	1 677	2 792
60	1 734	2 887
61	1 792	2 984
62	1 852	3 083
63	1 912	3 183
64	1 973	3 285
65	2 035	3 388

NOTES

1 To calculate the aggregate breaking force multiply the values given in column 3 by 1.136.

2 The values for masses are for guidance only.

Table 10 Sprial Strand 1 × 169 J (42:36:30:24:18:12:6-1) Construction

(*Clauses* 1 *and* 10)

Nominal Diameter (mm) +4% −1%	Approximate Mass kg/100 m	Minimum Breaking Force Corresponding to the Rope Grade of 1 570
(1)	(2)	(3)
		kN
40	771	1 283
41	810	1 348
42	850	1 415
43	891	1 483
44	933	1 553
45	975	1 624
46	1 019	1 697
47	1 064	1 772
48	1 110	1 848
49	1 157	1 925
50	1 204	2 005
51	1 253	2 086
52	1 303	2 168
53	1 353	2 253
54	1 405	2 339
55	1 457	2 426
56	1 511	2 515
57	1 565	2 606
58	1 620	2 698
59	1 677	2 792
60	1 734	2 887
61	1 792	2 984
62	1 852	3 083
63	1 912	3 183
64	1 973	3 285
65	2 035	3 388

NOTES

1 To calculate the aggregate breaking force multiply the values given in column 3 by 1.136.

2 The values for masses are for guidance only.

Table 11 Half and Full Locked Coil Wire Rope

(*Clauses* 1 *and* 10)

Nominal rope dia = d Mass factor (K) = 0.562 5 Rope mass (kg/100 m) = Kd^2
Breaking force factor (K') = 0.559 4 Rope grade (Tensile) = R_0 (i.e. 1 370 or 1 470)
Minimum breaking force of rope = $(K'.R_0.d^2)$ / 1 000 kN

Nominal Diameter (d) (mm) +4% −1%	Approximate Mass (kg/100 m)	Minimum Breaking Force of the Locked Coil Wire Rope Corresponding to the Rope Grade of	
		1 370	1 470
(1)	(2)	(3)	(4)
		kN	kN
26	380	518	556
28	441	601	645
30	506	690	740
32	576	785	842
34	650	886	951
36	729	993	1 066
38	812	1 107	1 187
40	900	1 226	1 316
42	992	1 352	1 451
43	1 040	1 417	1 520
44	1 089	1 484	1 592
46	1 190	1 622	1 740
48	1 296	1 766	1 895
50	1 406	1 916	2 056
51	1 463	1 993	2 139
52	1 521	2 072	2 224
53	1 580	2 153	2 310
54	1 640	2 235	2 398
56	1 764	2 403	2 579
58	1 892	2 578	2 766
60	2 025	2 759	2 960
62	2 162	2 946	3 161
64	2 304	3 139	3 368
66	2 450	3 338	3 582
68	2 601	3 544	3 802
70	2 756	3 755	4 029
72	2 916	3 973	4 263
74	3 080	4 197	4 503
76	3 249	4 427	4 750
78	3 422	4 663	5 003
80	3 600	4 905	5 263

NOTES

1 To calculate the aggregate breaking force multiply the values given in columns 3 and 4 by 1.09.
2 The values for masses are for guidance only.

ANNEX A

(*Clause* 11)

ELONGATION OR STRETCH OF WIRE ROPE/STRAND

A-1 STRECHES IN WIRE ROPE STRANDS

There are two kinds of stretches in a wire rope/strand.

A-1.1 Permanent Constructional Stretch

This is caused by the lengthening of the rope/strand lay and the reduction in rope/strand diameter. The extent of this stretch depends upon the rope /strand construction, the length of lay, the type of core and some other factors. For stranded operating ropes, this stretch varies from 0.25 percent to 1.0 percent depending upon the operating loads. For locked coil wire ropes and spiral strands the comparable figure of permanent constructional stretch would be from 0.15 percent to 0.5 percent.

A-1.2 Elastic Stretch

This is caused by the action of tensile stress on the metallic area of the rope/strand conforming to their elastic property. The amount of elastic stretch may be determined by the formula given below:

$$l_e = \frac{P \times L}{A \times E_r}$$

where

l_e = elastic stretch of rope/strand in cm;

P = load or tension on rope/strand in N;

L = initial length of rope/strand under stress in cm;

A = metallic area of rope/strand in cm^2; and

E_r = modulus of elasticity of rope/strand in N/cm^2 based on its metallic area.

A-2 MODULUS OF ELASTICITY

Commonly used approximate value of modulus of elasticity for various constructions of wire ropes/ strands covered under this specification are given in Table 12 . New or unused ropes/strands invariably have a total elongation under load greater than used rope/ strands of the same specification, since the larger part of the stretch occurs during the initial period of its useful life. Subsequently, the modulus of elasticity would also be smallest for a wire rope/strand during this period. Modulus of elasticity for old and used rope/ strand is approximately 20 percent in excess of values shown in Table 12.

It is for this reason that pre-stressed ropes/strands are preferred for construction of bridges. Pre-stressing is the process of cyclic loading of the rope/strand to 5 to 50 percent of the minimum breaking strength till the stretch in the rope/strand at any given load between 5 percent and 50 percent stabilizes. Table 12 indicates the comparative values prior to pre-stressing and after pre-stressing.

Table 12 Modulus of Elasticity of Rope/Strand

Sl No.	Type of Wire Rope/Strand	Construction	Modulus of Elasticity in N/cm^2	
			As Manufactured	Pre-stressed
1	Stranded rope	7 × 7	6.9×10^6	8.6×10^6
		7 × 19	6.5×10^6	8.1×10^6
		7 × 37	6.1×10^6	7.6×10^6
2	Spiral strand	1 × 7	11.0×10^6	13.1×10^6
		1 × 19	10.0×10^6	12.8×10^6
		1 × 37	9.5×10^6	12.8×10^6
		1 × 61	9.3×10^6	12.0×10^6
		1 × 91	9.0×10^6	11.7×10^6
		1 ×127	8.7×10^6	11.3×10^6
3	Full locked and half locked coil wire rope	–	10.3×10^6	13.1×10^6

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Wire Ropes and Wire Products Sectional Committee, ME 10

Organization	*Representative(s)*
Directorate General of Mines Safety, Dhanbad	SHRI D. SAHA (***Chairman***) SHRI S. P. BANSAL (*Alternate*)
Aerial Ropeway & Mechanical Handling Co Pvt Ltd, Kolkata	SHRI A. K. KINRA SHRI RANJAN MUKHERJEE (*Alternate*)
Amar Promoters Pvt Ltd, Solan	SHRI VIRENDER AGARWAL SHRI JATINDER AGARWAL (*Alternate*)
Bharat Coking Coal Ltd, Dhanbad	SHRI R. K. PRASAD
Bharat Wire Ropes Ltd, Mumbai	SHRI D. M. SHAH
Central Mining Research Institute, Dhanbad	SHRI S. P. CHAUDHARY SHRI R. P. CHAKRABORTY (*Alternate*)
Directorate General of Aeronautical Quality Assurance, New Delhi	SHRI S. B. PRASAD SHRI SANJAY CHAWLA (*Alternate*)
Directorate General of Civil Aviation, New Delhi	SHRI R. C. GUPTA SHRI. M. M. KAUSHAL (*Alternate*)
Eastern Coalfields Ltd, Kolkata	SHRI H. K. CHAKRABORTY
Fort William Industries Ltd, Hooghly	SHRI J. L. RATHI SHRI BASUDEB BANERJEE (*Alternate*)
JCT Ltd (Steel Division), Hoshiarpur	SHRI S. K. SETHI SHRI M. L. SHARMA (*Alternate*)
Ministry of Defence (Naval), New Delhi	CDR BRAHMASWAROOP SHRI. B. L. KHDWAL (*Alternate*)
Ministry of Surface Transport, New Delhi	SHRI G. P. ROY SHRI T.K. DUTTA (*Alternate*)
National Test House, Ghaziabad	SHRI D. S. MAJUMDAR SHRI B. N. SARKAR (*Alternate*)
North Eastern Coalfields Ltd, Kolkata	SHRI A. TIRKEY
Oil and Natural Gas Commission, Dehra Dun	SHRI R. K. GARG SHRI P. K. SOOD (*Alternate*)
Research Designs & Standards Organization, Lucknow	DEPUTY DIRECTOR (Standards)
South Eastern Coalfields Ltd, Bilaspur	SHRI S. K. MISHRA SHRI G. RAMASWAMI (*Alternate*)
Usha Breco Ltd; Kolkata	SHRI AMIT KUMAR BASU SHRI C. K. KARMAKAR (*Alternate*)
Usha Martin Industris Ltd, Ranchi	SHRI RANA PRATAP SHRI K. K. SENGUPTA (*Alternate*)
Vidarbha Hardware Industries, Akola	SHRI O. P. DALMIA SHRI SANJAY K. DALMIA (*Alternate*)
BIS Directorate General	SHRI M. L. CHOPRA, Director & Head (MED) [Representing Director General (*Ex-officio*)]

Member-Secretary
SHRI P. VENKATESWARA RAO
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