IS 7167 (1974): Code for selection and use of bucket elevators [MED 6: Continuous Bulk Conveying, Elevating, Hoisting Aerial Ropeways and Related Equipment]

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# *Indian Standard*

# CODE FOR SELECTION AND USE OF BUCKET ELEVATORS

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

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( Reaffirmed 1996 )

# *Indian Standard*

# CODE FOR SELECTION AND USE OF BUCKET ELEVATORS

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( *Continued on page* 2 )

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# *Indian Standard*

# CODE FOR SELECTION AND USE OF BUCKET ELEVATORS

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 28 January 1974, after the draft finalized by the Conveyors, Vertical Hoists and Bucket Elevators Sectional Committee had been approved by the Mechanical Engineering Division Council.

**0.2** Bucket elevators find an extensive application in industry for material handling. To suit the work which is expected of the bucket elevator, it is necessary that the proper type of bucket elevator is selected. This standard covers the recommendations in the selection and use of various types of bucket elevators. Recommendations regarding bucket elevators handling materials which do not behave like solids are not covered in this standard.

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## 1. SCOPE

**1.1** This standard lays down recommendations for use of three types of bucket elevators, namely, centrifugal, continuous and positive discharge, for handling bulk material.

**1.2** This standard does not apply to elevators handling materials which do not behave as solids.

## 2. TERMINOLOGY

**2.1** For the purpose of this standard, the definitions given in IS:4240-1967* shall apply.

## 3. SELECTION OF ELEVATOR

**3.1** The selection of the type of elevator is governed by the characteristics of the material handled, whether lumpy or fine, abrasive or non-abrasive and whether material will stand centrifugal discharge or it needs to be handled more slowly to avoid breakage.

*Glossary of conveyor terms and definitions.

**3.2 Centrifugal Discharge Elevators (I)** — This is the most commonly used type with buckets Type A1, A2, A3, and A4 (*see* IS:6833-1973*) mounted on belt or chain, spaced at intervals to avoid interference in loading and discharge. This is mostly vertical and handles practically and free flowing fine or small lump material such as grain, coal, sand, clay, sugar or dry chemicals. The lumps of moderate size can be handled using bucket sizes listed in IS:6833-1973*.

**3.3 Continuous Discharge Elevators (II)** — This is the elevator, often used for handling larger lumps and material that may be difficult to handle by centrifugal discharge elevators. Buckets are so shaped and mounted on chain or belt that, as they pass over the head wheel, the flanged end of the preceding bucket acts as a chute to lower material to the elevated discharge spout. The slow speed and gentle method of loading and discharging minimize breakage of fragile materials and also makes this a satisfactory type for pulverised or fluffy materials, such as lime, cement, or certain dry chemicals. Continuous buckets are not recommended to be filled in by digging and must be filled in by a loading leg. This type of elevator can be operated vertically or inclined; when inclined, special guides are furnished for carrying rim and wider casing provided to allow for sag in return run.

**3.4 Positive Discharge Elevators (III)** — This is similar to centrifugal discharge elevator except that spaced buckets are end-mounted between two strands of chain and are snubbed back under the head sprockets to invert buckets and gain complete discharge. Bucket speed is slower and this type is specially suited to handle light, aerated, dusty, and sticky materials that will not discharge without difficulty in centrifugal discharge elevator. The slight impact of chains skating on snubbed sprockets also helps to free materials, such as wet coal with tendency to stick to buckets.

**3.5** In Table 1 are given recommendations for selection of the type of elevator for different materials.

## 4. SELECTION OF SIZE OF ELEVATOR

**4.1** The size of the elevator will depend upon the maximum capacity (in t/h) that will ever be handled at any time which in turn will depend upon:

a) the bucket size,
b) the spacing of the buckets,
c) the speed of the bucket,
d) the bulk density of the material handled, and
e) the percentage filling of the bucket.

*Specification for buckets for bucket elevators.

**TABLE 1 RECOMMENDATION FOR SELECTION OF BUCKET ELEVATORS**

( *Clauses* 3.5 *and* 6.1 )

| MATERIAL | BULK DENSITY | BELT/CHAIN | TYPE OF ELEVATOR |
|---|---|---|---|
| (1) | (2) kg/m³ | (3) | (4) |
| Alum, lumpy | 800-960 | Chain | I, III |
| Alum, pulverised | 720-800 | Chain/belt | I, III |
| Aluminium chips | 240 | Chain | III |
| Aluminium ore | 1 200-1 350 | Chain | I, III |
| Aluminium oxide | 1 100-1 900 | Chain | III |
| Ashes | 560-640 | Chain | I |
| Bakelite, powdered | 480-640 | Chain/belt | II, III |
| Baking power | 800-900 | Chain/belt | II, III |
| Barley | 600 | Chain/belt | II, III |
| Bauxite, crushed and dry | 1 200-1 350 | Chain/belt | I, III |
| Beans, castor | 580 | Chain/belt | I, III |
| Bones, crushed | 560-650 | Chain | I, III |
| Bones, granulated or ground | 800 | Chain | I, III |
| Bone black | 320-400 | Chain | II, III |
| Bone meal | 880-960 | Chain/belt | I |
| Borax powdered | 850 | Chain/belt | I |
| Carbon, black pelletized | 320-400 | Chain | III |
| Carbon black powder, channel | 65-100 | Chain | II |
| Carbon black powder, furnace | 65-100 | Chain | II |
| Cast iron borings | 2 100-3 200 | Chain | I, III |
| Cement, Portland | 1 200-1 350 | Chain | I, III |
| Cement, clinker | 1 200-1 280 | Chain | I, III |
| Chalk, crushed | 1 350-1 450 | Chain | I, III |
| Chalk, pulverised | 1 120-1 200 | Belt/chain | III |
| Charcoal | 290-450 | Belt/chain | II, III |
| Cinders, coal | 640 | Chain | I, III |
| Clay ( brick or tile ) dry, ground | 1 600-1 920 | Belt | I, III |
| Coal anthracite | 960 | Chain/belt | I, III |
| Coal, anthracite, river coal and culm | 960 | Chain/belt | I, III |
| Coal, bituminous, stripping not cleaned | 800 | Chain/belt | I, III |
| Coffee | 350-510 | Chain/belt | I, III |
| Coke, loose | 370-510 | Belt | I |

( *Continued* )

TABLE 1 RECOMMENDATION FOR SELECTION OF BUCKET ELEVATORS — *Contd*

| MATERIAL | BULK DENSITY | BELT/CHAIN | TYPE OF ELEVATOR |
|---|---|---|---|
| (1) | (2) kg/m³ | (3) | (4) |
| Coke, petroleum | 560-720 | Belt | I |
| Coke, breeze | 400-560 | Belt | I |
| Cork | 190-240 | Belt/chain | II, III |
| Corn cracked | 680-720 | Belt/chain | I |
| Corn sugar | 500 | Belt/chain | I |
| Corn meal | 600-640 | Belt/chain | I |
| Cottonseed, dry, delinted | 400 | Belt | I |
| Cottonseed, dry, with lint | 290-400 | Belt | I |
| Cottonseed, cake, cracked | 640-720 | Belt/chain | I |
| Cottonseed hulls | 190 | Belt/chain | III |
| Cottonseed meal | 560-640 | Chain | I |
| Cottonseed meats | 640 | Chain | I |
| Cullet | 960-1 900 | Belt | I |
| Dolomite | 1 440-1 600 | Chain/belt | I, III |
| Feldspar, ground, powdered | 1 040-1 200 | Chain/belt | I, III |
| Flaxseed cake | 780-800 | Belt/chain | I |
| Flaxseed meal | 400 | Belt/chain | I |
| Flour, wheat | 560-640 | Belt | I |
| Flourspar | 1 300 | Belt/chain | I, III |
| Flue dust, blast furnace | 1 760-2 000 | Belt | I, III |
| Fuller's earth | 560-640 | Belt | I |
| Foundry sand | 1 440-1 600 | Belt | I |
| Glass batch | 1 400-1 600 | Belt | I |
| Grain, distillery, spend, dry | 480 | Belt/chain | I |
| Granite, broken | 1 500-1 600 | Chain | III |
| Grass seed | 160-195 | Chain/belt | III |
| Gravel | 1 440-1 600 | Chain/belt | I, III |
| Gypsum calcined | 880-960 | Chain | I, III |
| Gypsum, crushed under 25 mm | 1 400-1 600 | Chain/belt | I, III |
| Gypsum, powdered | 960-1 280 | Chain/belt | I, III |
| Ice, crushed | 560-720 | Chain | I, III |

( *Continued* )

**TABLE 1 RECOMMENDATION FOR SELECTION OF BUCKET ELEVATORS** — *Contd*

| MATERIAL | BULK DENSITY | BELT/CHAIN | TYPE OF ELEVATOR |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| | kg/m³ | | |
| Ilmenite ore | 2 240 | Chain | I, III |
| Lead oxide | 480-2 400 | Chain | I, III |
| Lignite, air dried | 720-880 | Chain | I, III |
| Lime, ground | 960 | Chain | I, III |
| Lime, hydrated | 560-720 | Chain/belt | III |
| Lime pebble | 900 | Chain/belt | III |
| Lime, over 12 mm | 850 | Chain/belt | I, III |
| Limestone | 1 360-1 440 | Chain/belt | I, III |
| Limestone, crushed | 1 360-1 440 | Chain/belt | III |
| Linseed meal | 680 | Belt/chain | I |
| Malt, dry ground | 320-335 | Belt/chain | I, II |
| Malt, dry whole | 430-480 | Belt/chain | I, II |
| Malt, meal | 570-640 | Belt/chain | I, II |
| Malt, wet or green | 640-720 | Belt/chain | I, II |
| Marble, crushed | 1 440-1 520 | Belt/chain | III |
| Milk, dried, flake | 575 | Belt/chain | I, III |
| Milk, malted | 430 | Belt/chain | I, II |
| Nitrate, sodium | 960 | Chain | I |
| Nitrate, ammonium | 850 | Chain | I, III |
| Nitrate, calcium ammonium | 1 000-1 100 | Belt/chain | I |
| Oxalic acid crystals | 960 | Belt | I |
| Paper pulp stock up to 15% | 960-1 000 | Chain | I, II |
| Paraffin cake, broken | 720 | Chain | I, III |
| Pebbles, over 25 mm | 1 440-1 600 | Belt/chain | I |
| Phosphate, acid, pulverized | 1 040-1 120 | Chain | I, III |
| Phosphate, granular | 1 440 | Chain | I, III |
| Phosphate fertilizers e.g. nitro-phosphate, super phosphate tri super phosphate, etc | 800-1 100 | Chain | I, III |
| Phosphate sand | 1 440-1 600 | Chain/belt | I, III |
| Phosphate, dimmonium | 880 | Belt/chain | I |
| Quartz, pulverised or granular | 1 760 | Belt/chain | I, III |

(*Continued*)

TABLE 1 RECOMMENDATION FOR SELECTION OF BUCKET ELEVATORS — *Contd*

| MATERIAL | BULK DENSITY | BELT/CHAIN | TYPE OF ELEVATOR |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| | kg/m³ | | |
| Rice, bran | 320 | Belt/chain | I |
| Rice grifts | 670-720 | Belt/chain | I |
| Rubber, ground | 370 | Belt/chain | I, III |
| Salt, dry fine | 1 120-1 280 | Belt/chain | I, III |
| Salt, dry coarse | 720-800 | Belt/chain | I, III |
| Sand, damp | 1 760-2 080 | Belt/chain | I |
| Sand dry | 1 440-1 760 | Belt | I |
| Sand, silica, dry | 1 440-1 600 | Belt | I |
| Shale crushed | 1 360-1 440 | Belt | I |
| Slag, furnace, granulated | 960-1 040 | Belt/chain | III |
| Slate, crushed, ground | 1 280-1 440 | Belt | I |
| Soda ash, light | 320-580 | Chain | III |
| Soda ash, heavy | 880-1 040 | Chain | I, III |
| Soybeans, cracked | 510-580 | Chain | I |
| Soybean, flour | 430 | Belt | I |
| Starch | 720 | Belt | I, III |
| Steel chips, crushed | 1 600-2 400 | Chain | III |
| Stone, crushed | 1 360-1 440 | Chain | I, III |
| Sugar beet, pulp, dry | 170-240 | Chain | II, III |
| Sugar beet, pulp, wet | 400-720 | Chain | III |
| Sugar raw | 880-1 040 | Chain/belt | I |
| Sugar, refined | 800-880 | Belt/chain | I |
| Sulphur, lumpy | 1 280-1 360 | Chain | I, III |
| Sulphur, powdered | 800-960 | Belt | I, III |
| Talc | 800-960 | Belt | I, III |
| Urea | 650 | Belt/chain | I, III |
| Wheat, cracked | 640-720 | Belt/chain | I |
| Wood, chips | 190-320 | Belt | I |
| Zinc ore, crushed | 1 960 | Chain | I |
| Zinc oxide | 160-580 | Chain | I, III |

NOTE :

I = Centrifugal discharge bucket elevator.
II = Positive discharge bucket elevator.
III = Continuous bucket elevator.

**4.2 Capacity Calculation** — General formula for calculation of the capacity of all types of elevator shall be follows:

$$T = \frac{F \times C \times W \times 3\,600 \times V \times 10^{-4}}{100 \times S}$$

where

$T$ = capacity of bucket elevator in t/h;

$F$ = constant, representing percentage filling of the buckets;

$C$ = capacity of individual bucket in l;

$W$ = material bulk density in kg/m$^3$;

$V$ = belt or chain speed in m/sec; and

$S$ = bucket spacing in m.

**4.2.1** The values for $F$, $V$, and $S$ shall be taken from Tables 2, 5, 6, 7 and 8.

**4.2.2** Depending on the value of $C$ determined from the above formula the bucket size for different type of buckets shall be according to IS : 6833-1973*.

**4.3 Selection of Bucket** — The selection of the type of bucket shall be done on the basis of type of elevator that is centrifugal or continuous type according to recommendations given below:

| *Type of Elevator* | *Type of Bucket According to IS : 6833-1973** | *Recommended Application* |
|---|---|---|
| Centrifugal and positive discharge | A1 | For powdered and free flowing material |
| | A2 | For cement, coal, sand, gravel, stone, pulp, ores chemicals, fertilizers and similar other materials |
| | A3 | For wet, stringly materials likely to stick in buckets. Also used for handling stones and ores and other coarsely broken material on inclined elevators |
| | A4 | Used for sugar, clay, salt, pulverised wet ores which tend to pack in the buckets |

*Specification for buckets for bucket elevators.

| *Type of Elevator* | *Type of Bucket According to IS : 6833-1973** | *Recommended Application* |
|---|---|---|
| Continuous discharge | B1 | Used for pulverised and sluggish material that stick or pack in buckets and on inclined elevators |
| | B2 | Used for average materials for vertical elevators |
| | B3 | Used when extra capacity and large lumps are to be handled |
| | B4 | Used on inlined bucket elevators not over 70°C inclination with horizontal |

## 5. SELECTION OF CASING

**5.1** The selection of casing shall generally be done on the basis of type of elevator and bucket size as per IS : 7054-1973† but the selection of take up at the boot shaft or head shaft shall be done according to the following recommendations.

**5.2 Take Up at Head Shaft** — The take up at head shaft is recommended to be used in case:

a) material handled is likely to take up after some time of storage, as in case of chemical fertilizer, cement, etc;

b) where accumulation of material in boots results in deterioration of quality as in food products;

c) when elevator is required to handle different products which should not be mixed;

d) where material handled is coarse, hard and lumpy but approximately round or cubical only. In case of sharp cornered pieces, fixed bearing boot is not recommended;

e) where confinement of material to bucket path is not necessary, for example, hot clinker elevator in cement mills; and

f) where from layout point the loading pit is so placed that approach is difficult, take up at head shaft is preferred.

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*Specification for buckets for bucket elevators.
†Specification for casing for bucket elevators.

**5.3 Take Up at Boot Shaft** — Except for cases mentioned in **5.2** take up should always be provided at the boot shaft due to following advantages:

a) Easy approach for adjustment of tension,

b) Direct drive to head sprocket, and

c) Possibility of provision of an automatic take up.

**TABLE 2 RECOMMENDED PERCENTAGE BUCKET FILLING FACTOR, *F***

( *Clause* 4.2.1 )

| MATERIAL CHARACTERISTICS | TYPE OF BUCKET ELEVATOR | *F* |
|---|---|---|
| Powdered (ground) e.g. coal dust, cement, chalk, phosphate fertiliser, etc | Positive discharge | 0·85 |
| | Centrifugal discharge | 0·75 |
| Granular and small lumped (60 mm) mildly abrasive e.g. saw dust, dry clay in lumps, coal, peat, grain, etc | Centrifugal discharge | 0·7 to 0·8 |
| Granular and small lumped (60 mm) highly abrasive e.g. gravel, ore slag, sand, ash, earth, rock, etc | Continuous discharge | 0·7 to 0·85 |
| | Centrifugal discharge | 0·7 to 0·8 |
| Medium and large lumped (60 mm) mildly abrasive e.g. coal, peat in lumps, etc | Continuous discharge | 0·6 to 0·8 |
| | Centrifugal discharge | 0·5 to 0·7 |
| Medium and large lumped (60 mm) highly abrasive e.g. crushed ore, stone, slag | Continuous discharge | 0·6 to 0·8 |
| Lumped, fraglite, down graded by crushing e.g. char coal, coke, etc | Continuous discharge | 0·6 |
| Sluggish, powdered and granular, moist e.g. moist chemicals, fluffed peat, earth, wet sand, wet powdered chalk, etc | Positive discharge | 0·4 to 0·6 |
| | Centrifugal discharge | 0·4 to 0·6 |

NOTE — While selecting value of *F*, effect of inclination of the elevator should be taken into account.

**5.4** Amount of take up shall vary up to 500 mm but shall never be less than 200 mm in any case.

## 6. SELECTION OF CHAIN AND BELT

**6.1** General recommendations for using chain or belt for different materials is listed in Table 1. However, guidelines for selection of chains or belts shall be as follows.

**6.1.1** Chains are normally used when the required duties are heavier or when the material to be handled is hot, hard and lumpy, abrasive or corrosive, that excessively limit the life of the belt or which pack between the bucket and the belt. For positive discharge elevators and for long bucket elevators requiring extra strength, chain should be used.

**6.1.2** Belts are used on elevators handling grains, cereals and many other free flowing or abrasive materials, for example, coke breeze, glass batch, etc. Belts are also used for handling corrosive materials such as caustic soda, salts, chemical fertilizer. With belts it is possible to run elevator at higher speeds thus resulting in higher capacity with smaller buckets, giving smoother and quicker operation. However, belts are not recommended for wet material, hard and splintery lumps and hot materials or those materials which tend to pack between bucket and belt.

**6.2** Once use of chain or belt is finalized the selection of either on strength basis is done as follows.

**6.2.1** *Chains* — Four types of chains having a wide range of application in elevator service are bushed chains, bushed pintle chains, bushed roller chains and combination chains. Careful judgement should be used in selection to ensure long life and suitability to service. The rating given by the manufacturer or relevant Indian Standards should be used and a working load based on a factor of at least 6:1 in relation to the ultimate strength of the chain should be adopted. Method of calculating maximum tension should be as follows:

$$T_m = T_a + T_b + T_w + T_f$$

where

$T_m$ = maximum chain tension in N,

$T_a$ = tension due to mass of chain in N,

$T_b$ = tension due to mass of buckets in N,

$T_w$ = tension due to mass of material in buckets in N, and

$T_f$ = tension due to mass of pick up of material in N.

The individual tensions may be estimated from the following formula:

$T_a$ = Height of elevator ($H$) × mass of chain in kg/m

$$T_b = \frac{H \times \text{mass of one bucket in kg}}{\text{Spacing of bucket } (S)}$$

$$T_w = \frac{H \times \text{mass of material in one bucket in kg}}{\text{Spacing of bucket } (S)}$$

$$T_f = \frac{Ho \times \text{mass of material in one bucket in kg}}{\text{Spacing of bucket } (S)}$$

where

$H_o$ = height factor to allow for pick up force in m,
= 10 m for centrifugal and positive discharge elevator,
= 3 m for continuous type.

**6.2.2** *Belt* — The selection of belt should be done on the basis of the following:

a) *Belt width* — should be 10 to 12 percent wider than the length of the bucket but not less than 40 mm on narrow belts.

b) *Number of plies* — minimum number of plies should be chosen from Table 3.

c) *Fabric grade and cover thickness* — The fabric and grade of cover to be chosen according to recommendation given in IS : 1891 (Part I)-1968* and the cover thickness shall be as given in Table 4.

d) *Belt tension* — In most of the cases (a), (b) and (c) above determine the complete design of the belt, however, it is always necessary to check whether the above belt is suitable for maximum tension, which is computed as follows:

1) Tension due to mass of belt = $B \times H$ in N

2) Tension due to mass of

$$\text{bucket} = \frac{H \times b}{\text{Spacing of bucket } (S)} \text{ in N}$$

3) Tension due to mass of load in

$$\text{bucket} = \frac{H \times W}{\text{Spacing of bucket } (S)} \text{ in N}$$

*Specification for rubber conveyor and elevator belting : Part I General purpose belting.

4) Tension due to mass of pick up load and over coarse pully friction

$$= \frac{Ho \times W}{\text{Spacing of bucket } (S)} \text{ in N}$$

Max tension = (1) + (2) + (3) + (4)

$$= B \times H + \frac{H \times b}{S} + \frac{HW}{S} + \frac{Ho \times W}{S} \text{ in N} \quad ...(A)$$

where ratio of material load in buckets to the weight of the belt and buckets is high, it may become necessary to apply additional tension at the boot pulley in order that the head pulley will drive the elevator properly. In such case the maximum tension is calculated as:

$$\text{Max tension} = (1 + K) \frac{W}{S} (H + Ho) \text{ in N} \quad ...(B)$$

The larger of the two values obtained from (A) and (B) is used for selection of the belt in above equation.

where

$B$ = belt mass in kg/m run,

$H$ = vertical height of elevator in m,

$S$ = bucket spacing in m,

$W$ = mass of material in each bucket in kg,

$b$ = bucket mass in kg,

$Ho$ = height factor to allow for pick up force and boot pulley friction (*see* **6.2.1**),

$K$ = 0·97 for bare pulley drive with screw take up,

= 0·80 for lagged pulley drive and screw take up,

= 0·64 for bare pulley drive with gravity take up,

= 0·5 for lagged pulley drive with gravity take up.

Therefore

$$\text{Number of plies} = \frac{\text{Maximum tension in N}}{\left(\begin{matrix}\text{Width of} \\ \text{belt in cm}\end{matrix}\right) \times \left(\begin{matrix}\text{Working tension} \\ \text{per ply in N/cm*}\end{matrix}\right)}$$

*The values shall be taken for IS : 1891 (Part I)-1968 'Specification for rubber conveyor and elevator belting: Part I General purpose belting (*first revision*)' after converting the values from kgf/cm to N/cm.

**TABLE 3 MINIMUM NUMBER OF PLIES BASED ON PROJECTION OF BUCKET**

( *Clauses* 4.2.1 *and* 6.2.2 )

| CLASS OF MATERIAL | PROJECTION OF BUCKET IN mm | | | | | | |
|---|---|---|---|---|---|---|---|
| | 100 | 125 | 150 | 180 | 200 | 230 | 250 |
| Light powdery or free flowing materials free from lumps | 4 | 4 | 5 | 5 | 5 | 6 | 6 |
| Cement, dry coal, dry sand, pea-coal, fertilizers heavy but free from lumps | 4 | 5 | 5 | 6 | 6 | 7 | 7 |
| Gravel, coarse sand, crushed stone, coal, light ores, etc | 5 | 6 | 6 | 7 | 7 | 8 | 8 |
| Lumpy or sticky materials heavy ores of other similar materials | — | 7 | 7 | 8 | 8 | 9 | 10 |

**TABLE 4 FACE AND BACK COVER FOR ELEVATOR BELTS**

( *Clauses* 4.2.1 *and* 6.2.2 )

| CLASS OF MATERIAL | COVER THICKNESS IN mm | |
|---|---|---|
| | Pulley Side | Bucket Side |
| Light powdery or free flowing material free from lumps such as coal dust, cement, chalk, etc | 1·0-1·5 | 1·0 |
| Ashes, coarse coal, sand and gravel crushed stone wet ores or grain | 1·5-3·0 | 1·0-1·5 |
| Coarse gravel, coarse stone, heavy buckets or severe abrasion | 1·5-5 | 1·5-3 |
| Most severe service due to abrasion or large buckets | 5-6 | 3-5 |

NOTE — Face cover on continuous bucket elevator need only be 1·0-1·5 mm.

## 7. PULLEY/SPROCKET DIAMETER *vs* SPEED

### 7.1 Pulley Diameters for Elevators Using Belt

**7.1.1** Normally the head pulley diameters are governed by the recommended speed and diameter relationship given in Table 5. However, minimum diameter of head and boot pulley governed by number of plies in the belt are given in IS : 1891 ( Part I )-1968*.

*Specification for rubber conveyor and elevator belting: Part I General purpose belting ( *first revision* ).

**TABLE 5 PULLEY DIAMETERS FOR ELEVATORS FOR VARIOUS MATERIALS**

( *Clauses* 4.2.1 *and* 7.1.1 )

| Head Pulley | Material Condition 'A' Coarse and Lumpy | | Material Condition 'B' Fine Free Flowing e.g. Grains | |
|---|---|---|---|---|
| | Pulley | Belt Speed $V$ | Pulley | Belt Speed $V$ |
| (1) | (2) | (3) | (4) | (5) |
| | rpm | r/s | rpm | m/s |
| 500 | 44 | 1·15 | 58 | 1·52 |
| 630 | 40·6 | 1·34 | 51 | 1·68 |
| 800 | 37 | 1·55 | 43·7 | 1·87 |
| 1 000 | 32·8 | 1·72 | 40 | 2·09 |
| 1 250 | 29·5 | 1·93 | 36 | 2·36 |
| 1 400 | 28 | 2·05 | 34·4 | 2·52 |
| 1 600 | 26·4 | 2·21 | 32·1 | 2·69 |
| 1 800 | 24·2 | 2·38 | 30·2 | 2·85 |

Note 1 — When handling light fluffy materials the speed given above under condition 'A' should be reduced by 15 to 20 percent.

Note 2 — For continuous discharge elevators 50 to 60 percent of the speeds given above are recommended.

**7.1.2** Spacing of the buckets for centrifugal and continuous type elevators shall be as given in Tables 6 and 7.

## 7.2 Sprocket Diameters *vs* Speed for Elevators Using Chains

**7.2.1** Chain speed for centrifugal discharge elevator depends on the size of the bucket, the bucket spacing and the diameter of the head and tail sprocket. To ensure efficient loading and discharge of the material recommendations are given in Table 6.

**7.2.2** Chain speed for positive discharge elevators is recommended to be in the range of 0·6 m/s and corresponding bucket spacing and sprocket diameters are given in Table 7.

**7.2.3** For continuous type of elevators, recommended speed ranges from 0·5 m/s to 0·9 m/s. The lower speed means better filling, less spillage and scatter into the loading boot and lesser pull on the bucket fixing belts at the loading point and in going round and head and foot sprockets. However, lower limit of speed for a particular material is one which will prevent dribbling of the material into the gap between the buckets. The higher limit of speed is determined by the value of material and boot loading condition of the buckets. The recommendation for sprocket diameters and spacing of the buckets is given in Table 8.

**TABLE 6 RECOMMENDED SPEED, SPACING AND SPROCKET DIAMETER FOR CENTRIFUGAL DISCHARGE BUCKET ELEVATORS**

( *Clauses* 4.2.1, 7.1.2 *and* 7.2.1 )

| Bucket Length | Chain Speed $V$ | Bucket Spacing $S$ | Sprocket Diameter | |
|---|---|---|---|---|
| | | | Head Sprocket | Boot Sprocket |
| (1) | (2) | (3) | (4) | (5) |
| mm | m/s | mm | mm | mm |
| 150 | 1·15 | 320 | 500 | 355 |
| 175 | 1·15 | 400 | 500 | 355 |
| 200 | 1·15 | 400 | 500 | 355 |
| 250 | 1·35 | 400 | 635 | 410 |
| 310 | 1·35 | 400 | 635 | 410 |
| 360 | 1·55 | 480 | 760 | 585 |
| 410 | 1·55 | 480 | 760 | 585 |
| 460 | 1·55 | 480 | 760 | 585 |
| 510 | 1·55 | 480 | 760 | 585 |
| 560 | 1·55 | 480 | 760 | 585 |
| 610 | 1·55 | 480 | 760 | 585 |
| 610* | 1·55 | 630 | 760 | 585 |
| 800 | 1·55 | 630 | 760 | 585 |
| 1 000 | 1·55 | 630 | 760 | 585 |

*For bucket size 610×255×270.

**TABLE 7 RECOMMENDED SPEED, SPACING AND SPROCKET DIAMETER FOR POSITIVE DISCHARGE BUCKET ELEVATORS**

( *Clauses* 4.2.1, 7.1.2 *and* 7.2.2 )

| Bucket Length | Chain Speed $V$ | Bucket Spacing $S$ | Sprocket Diameter | | |
|---|---|---|---|---|---|
| | | | Head Sprocket | Boot Sprocket | Snub Sprocket |
| (1) | (2) | (3) | (4) | (5) | (6) |
| mm | m/s | mm | mm | mm | mm |
| 150 | 0·61 | 500 | 625 | 425 | 300 |
| 175 | 0·61 | 500 | 625 | 425 | 300 |
| 200 | 0·61 | 500 | 625 | 425 | 300 |
| 250 | 0·61 | 500 | 625 | 425 | 300 |
| 310 | 0·61 | 500 | 625 | 425 | 300 |
| 360 | 0·61 | 630 | 780 | 635 | 445 |
| 410 | 0·61 | 630 | 780 | 635 | 445 |
| 460 | 0·61 | 630 | 780 | 635 | 445 |
| 510 | 0·61 | 630 | 780 | 635 | 445 |
| 560 | 0·61 | 630 | 780 | 635 | 445 |
| 610 | 0·61 | 630 | 780 | 635 | 445 |
| 800 | 0·61 | 630 | 780 | 635 | 445 |
| 1 000 | 0·61 | 630 | 780 | 635 | 445 |

TABLE 8 RECOMMENDED SPACING AND SPROCKET DIAMETER FOR CONTINUOUS TYPE BUCKET ELEVATORS

( *Clauses* 4.2.1 *and* 7.2.3 )

All dimensions in millimetres.

| Bucket Size | | Bucket Spacing | Sprocket Diameter | |
|---|---|---|---|---|
| Length | Projection | $S$ | Head Sprocket | Boot Sprocket |
| (1) | (2) | (3) | (4) | (5) |
| 150 | 75 | 150 | 500 | 560 |
| 200 | 125 | 200 | 500 | 360 |
| 250 | 150 | 200 | 500 | 360 |
| 250 | 180 | 320 | 635 | 445 |
| 310 | 180 | 320 | 635 | 445 |
| 310 | 200 | 320 | 635 | 445 |
| 360 | 180 | 320 | 635 | 445 |
| 360 | 200 | 320 | 635 | 445 |
| 410 | 200 | 320 | 635 | 445 |
| 460 | 200 | 320 | 635 | 445 |
| 460 | 300 | 480 | 635 | 445 |
| 510 | 250 | 320 | 735 | 445 |
| 510* | 300 | 480 | 735 | 445 |
| 610 | 250 | 480 | 735 | 445 |
| 610† | 300 | 480 | 735 | 445 |

*For bucket size 510 × 300 × 460.
†For bucket size 610 × 300 × 460.

## 8. POWER REQUIREMENTS OF THE ELEVATOR

**8.1** Wherever possible bucket elevator should be driven at head shaft and based on this assumption the power required for elevator can be calculated as follows:

$$\text{Head shaft power input in kN} = \frac{T_e \times V}{10}$$

where

$V$ = belt or chain speed in m/s, and

$T_e$ = effective tension in kN,

$= (H + Ho) \times \frac{W}{S}$ ($H$, $Ho$, $W$ and $S$ are the same as given in **6.2.2**).

$$\text{Motor output in kW} = \frac{\text{Head shaft power input}}{\text{Efficiency of drive}}$$

**8.2** Motor output obtained from **8.1** is to be rounded off to the next higher preferred output of the electric motor conforming to IS : 325-1970*.

## 9. SAFETY

**9.1 Hold Back** — A hold back of enclosed roller or sprocket cam type shall be provided on all elevator, designed for 150 percent torque, sufficient to hold the head shaft of the loaded elevator in case of power cut off to avoid drifting back of loaded buckets.

**9.2** Wherever jamming of bucket elevator is anticipated besides electrical overload tripping off, additional safety provision in couplings such as shear pin, etc, shall be kept. In critical services even use of fluid coupling between motor and gear box is recommended.

**9.3** Inspection holes at convenient levels and boot cleaning door should be provided in the elevators.

*Specification for three-phase induction motors (*third revision*).

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