MATERIAL STANDARD

FOR

BUILDING MATERIALS

PART ONE

CONTENTS :

PAGE No.

1. SCOPE

This Material Standard gives the minimum requirements for building material in two parts:

The first part of this Standard includes specifications, sampling, inspection, testing and storage of following materials:

a) Aggregates,
b) Building stone,
c) Clay bricks,
d) Gypsum and gypsum products,
e) Blocks and tiles (unglazed),
f) Glass.

Second part of this Standard includes minimum requirements for following building materials:

g) Ceramic tiles,
h) Vitreous china sanitary appliances,
i) Waterproofing materials,
j) Plastic floor covering,
k) Grating,
l) Sound adsorption tiles,
m) Paints,
n) Wooden doors and furnitures,
o) Aluminum doors and furnitures,
p) Structural steels.

This Standard is intended to be used in oil, gas and petrochemical industries for general building construction purposes.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant/Contractor.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM-A421-80 (1985)	"Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete"
ASTM-C29-78	"Test Method for Unit Weight and Voids in Aggregate"
ASTM-C33-86	"Specification for Concrete Aggregates"
ASTM-C40-84	"Test Method for Organic Impurities in Fine Aggregates for Concrete"
ASTM-C87-83	"Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar"
ASTM-C88-83	"Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate"
ASTM-C97-83 (1988)	"Test Methods for Absorption and Bulk Specific Gravity of Natural Building Stone"
ASTM-C114-88	"Method for Chemical Analysis of Hydraulic Cement"
ASTM-C123-83	"Test Method for Lightweight Pieces in Aggregate"

ASTM-C136-84	"Method of Sieve Analysis of Fine and Coarse Aggregates"
ASTM-C140-75 (1988)	"Method of Sampling and Testing of Concrete Masonry Units"
ASTM-C142-78 (1984)	"Test Method for Clay Lumps and Friable Particle Aggregates"
ASTM-C144-87	"Specification for Aggregate for Masonry Mortar"
ASTM-C270-89	"Specification for Mortar for Unit Masonry"
ASTM-C330-87	"Specification for Lightweight Aggregates for Structural Concrete"
ASTM-C331-87	"Specification for Lightweight Aggregates for Concrete Masonry Units"
ASTM-C332-87	"Specification for Lightweight Aggregates for Insulating Concrete"
ASTM-C404-87	"Specification for Aggregates for Masonry Grout"
ASTM-C641-82 (1986)	"Test Method for Staining Materials in Lightweight Concrete Aggregates"
ASTM-D75-87	"Practices for Sampling Aggregates"
ASTM-D448-86	"Classification for Standard Sizes of Aggregate and Bridge Construction"
ASTM-D692-88	"Specification for Coarse Aggregate for Bituminous Paving Mixture"
ASTM-D693-84	"Specification for Crushed Aggregate for Macadam Pavements"
ASTM-D1073-88	"Specification for Fine Aggregate for Bituminous Paving Mixture"
ASTM-D1139-83	"Specification for Crushed Stone, Crush Slag, and Gravel for Single or Multiple Bituminous Surface Treatments"
ASTM-D2940-74 (1986)	"Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports"
ASTM-E11-87	"Specification for Wire-Cloth Sieves for Testing Purposes"

BSI (BRITISH STANDARDS INSTITUTION)

BS 952 Part 1: 1978, Part 2: 1980	"Glass for Glazing"
BS 5896: 1980	"Specification for High Tensile Steel Wire and Strand for the Prestressing of Concrete"

IPS (IRANIAN PETROLEUM STANDARD)

IPS-M-CE-182	"Road Surfacing and Pavements"
IPS-M-CE-165	"Materials for Concrete, Mortars and Admixtures"

ISIRI (INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCH OF IRAN)

ISIRI 7-1364	"Clay Brick"
ISIRI 70-1372	"Cement Block"
ISIRI 269-1366	"Plaster (Building Material)"

ISIRI 299-1370	"Fine Sand for Cement Mortar"
ISIRI 300- 1364	"Fine Aggregate for Concrete and Reinforced Concrete"
ISIRI 302-1345	"Sand for Concrete and Reinforced Concrete"
ISIRI 389 to 394-1370	"Specification and Test Methods for Portland Cement"
ISIRI 448-1363	"Method of Tests of Abrasion of Coarse Aggregates by Use of the Los-Angeles Machine"
ISIRI 578-1365	"Wall and Facing Materials-Methods of Determination of Water Absorption and Resistance to Freezing and Thawing"
ISIRI 617-1364	"Wall and Facing Materials-Methods for Determination of Ultimate Compressive and Bending Strengths"
ISIRI 618-1364	"Blocks of Natural Stone for Sawing Facing Slabs"
ISIRI 755-1351	"Terrazzo Tiles"
ISIRI 897-1356	"Specifications and Methods of Test for Glasses Used in Building"
ISIRI 1162-1367	"Specification for Clay for Making Brick"
ISIRI 1900-3-1370	"Code of Practice for Concrete and Reinforced Concrete-Specification of Materials and Test Methods"
ISIRI 2385-1365	"Safety Glasses for Building"
ISIRI 2786-1373	"Gypsum Partition Panels"
ISIRI 2909-1370	"Joist and Filler Blocks of Roof"

JIS (JAPANESE INDUSTRIAL STANDARD)

R 3201-1981	"Sheet Glasses"
R 3202-1981	"Float and Polished Plate Glasses"
R 3203-1981	"Figured Glasses"
R 3204-1981	"Wired Glasses"

3. DEFINITIONS AND TERMINOLOGY

Definition and terminology of this Standard shall be in accordance with following terminologies:

a) ASTM-E631-89a "Terminology of Building Constructions"
b) ASTM-C125-88 "Definitions of Terms Relating to Concrete and Concrete Aggregates"
c) ASTM-C896-87 "Definitions of Terms Relating to Clay Products"
d) ASTM-C162-88 "Definitions of Terms Relating to Glass and Glass Products"
e) ASTM-C11-89 "Definitions of Terms Relating to Gypsum and Related Building Materials and Systems"
f) ASTM-C119-87a "Definitions of Terms Relating to Natural Building Stones"

4. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

5. AGGREGATES

5.1 General

5.1.1 The aggregates used in concrete and masonry materials comprise uncrushed and/or crushed natural and/ or artificial mineral substances with particle size and shapes. Aggregates can be classified in terms of their density as follows:

5.1.2 Light-weight

Aggregates with porous structure and particle density of less than 2000 kg/m^3 used to prepare light-weight plaster and concrete.

5.1.3 Normal-weight

Aggregates with a particle density greater than 2000 kg/m^3 but not exceeding 3000 kg/m^3. Normal-weight aggregate includes fine and coarse aggregates used for making mortar plaster and concrete.

5.1.4 Heavy-weight

Aggregates with a particle density greater than 3000 kg/m^3.

5.1.5 Aggregate shall not be contaminated by other materials during transit or during storage on site. Particle size fractions requiring to be transported separately shall be stored so as to exclude the possibility of their mixing. Ready-mixed aggregate shall be unloaded and stored in such a manner as to prevent segregation.

5.2 Fine Aggregates

5.2.1 Types

5.2.1.1 Fine aggregates shall consist of natural sand and manufactured sand or a combination thereof.

5.2.1.2 The natural sand consists of uncrushed sand, partially crushed sand, crushed gravel and crushed rock.

5.2.1.3 Manufactured sand is the product obtained by crushing stone, gravel, or air cooled iron blast-furnace slag specially processed to assure suitable particle shape as well as gradation.

5.2.2 Uses

Fine aggregate can be used for making cement mortar, concrete and bitumen paving mixture.

This Standard specifies the requirements of fine aggregate used in cement mortar in accordance with ISIRI 299. For specification of sand used in concrete refer to IPS-M-CE-165 and also ASTM C-33, and for bitumen paving mixture application see IPS-G-CE-182 and ASTM D1073.

5.2.3 Method of sampling

Sampling of aggregates should be in accordance with ASTM D75.

5.2.4 Grading

5.2.4.1 The grading shall conform to the requirements given in Table 1 in accordance with standard specification ASTM E 11 (sieves) and ASTM C136.

5.2.4.2 The aggregate shall not have more than 50% retained between any two consecutive sieves of those listed in Table 1 nor more than 25% between No. 50 (300 μm) and the No. 100 (150 μm) sieve.

TABLE 1 - GRADING REQUIREMENTS OF FINE AGGREGATE

SIEVE SIZE	AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS), WEIGHT %		
	Size No. 1*	Size No. 2**	
		NATURAL	MANUFACTURED
½-in. (12.5 mm)	—	—	—
3/8-in. (9.5 mm)	100	—	—
No. 4 (4.75 mm)	95 to 100	100	100
No. 8 (2.36 mm)	80 to 100	95 to 100	95 to 100
No. 16 (1.18 mm)	50 to 85	70 to 100	70 to 100
No. 30 (600 μm)	25 to 60	40 to 75	40 to 75
No. 50 (300 μm)	10 to 30	10 to 35	20 to 40
No. 100 (150 μm)	2 to 10	2 to 15	10 to 25
No. 200 (75 μm)	—	—	0 to 10

*** Size No 1 is that specified for concrete fine aggregate (see ASTM C33).**

*** Size No 2 is that specified for masonry mortar aggregate (see ASTM C144).**

5.2.5 Deleterious substances

5.2.5.1 The amounts of deleterious substances in fine aggregate for masonry mortar shall not exceed those specified in Table 2.

TABLE 2 - LIMITS FOR DELETERIOUS SUBSTANCES IN FINE AGGREGATE FOR MASONRY MORTAR

ITEM	MAXIMUM PERMISSIBLE WEIGHT (PERCENT)	TEST METHOD
Friable particles	1.0	C 142
Lightweight particles, floating on liquid having a specific gravity of 2.0	0.5*	C 123

*** This requirement does not apply to blast-furnace slag aggregate**

5.2.5.2 Organic impurities (ASTM C40)

Fine aggregate shall be free of injurious amounts of organic impurities. Except as herein provided, aggregates subjected to the test for organic impurities and producing a color darker than the standard shall be rejected.

A fine aggregate failing in the test may be used, provided that the discoloration is due principally to the presence of small quantities of coal, lignite, or similar discrete particles.

A fine aggregate failing in the test may be used, provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 days calculated in accordance with Test Method ASTM C87, is not less than 95%.

5.2.6 Soundness (ASTM C88)

5.2.6.1 Except as herein provided, fine aggregate subjected to five cycles of the soundness test shall have a weighted average loss not greater than 10% when sodium sulfate is used or 15% when magnesium sulfate is used.

5.2.6.2 Fine aggregate failing to meet the requirements of 5.2.6.1 may be accepted, provided that concrete of comparable properties, made from the same source, has given satisfactory service when exposed to weathering similar to that to be encountered.

5.2.7 Density

The density of fine aggregate should be determined in accordance with test method ASTM C128. Use the density determined in the calculation of the air content of the mortar, as required by ASTM C 270.

5.3 Coarse Aggregates

5.3.1 Types

Coarse aggregates shall consist of gravel, crushed gravel, crushed stone, air-cooled blast furnace slag, or a combination thereof.

5.3.2 Uses

5.3.2.1 The coarse aggregates can be used for making the following mixtures:

- **a)** Concrete (see IPS-M-CE-165 and also ASTM C33-86)
- **b)** Macadam pavements (see ASTM D693-84)
- **c)** Single and multiple bituminous surface treatment (see ASTM D 1193-83)
- **d)** Masonry grout (see ASTM C404-87)
- **e)** Road and bridge construction (see ASTM D448-86)
- **f)** Bases or subbases of highways and airports (see ASTM D2940-74)
- **g)** Bitumen paving mixture (see ASTM D692-88)

5.3.2.2 This Standard specifies the requirements of coarse aggregates used for making masonry grout and mortar.

5.3.3 Sampling

Sampling of aggregates should be in accordance with ASTM D-75-87.

5.3.4 Grading (As per ASTM E11-87 and ASTM C136-84a)

The grading shall conform to the requirements given in Table 3.

5.3.5 Deleterious substances

The amount of deleterious substances in coarse aggregate for masonry mortar shall not exceed those specified in Table 2.

TABLE 3 - GRADING REQUIREMENTS FOR COARSE AGGREGATES

SIZE No.	NOMINAL SIZE (Sieves with Square Openings)	AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE-OPENINGS) WEIGHT PERCENT												
		4 1n. (100 mm)	3½ in. (90 mm)	3 in. (75 mm)	2½ in. (63 mm)	2 in. (50 mm)	1½ in. (37.5 mm)	1 in. (25 mm)	¾ in. (19 mm)	½ in. (12.5 mm)	3/8 in. (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18 mm)
1	3½ to 1½ in. (90 to 37.5 mm)	100	90 to 100	—	25 to 60	—	0 to 15	—	0 to 5	—	—	—	—	—
2	2½ to 1½ in. (63 to 37.5 mm)	—	—	100	90 to 100	35 to 70	0 to 15	—	0 to 5	—	—	—	—	—
3	2 to 1 in. (50 to 25 mm)	—	—	—	100	90 to 100	35 to 70	0 to 15	—	0 to 5	—	—	—	—
357	2 in. to No. 4 (50 to 19 mm)	—	—	—	100	95 to 100	—	35 to 70	—	10 to 30	—	0 to 5	—	—
4	1½ to ¾ in. (37.5 to 19 mm)	—	—	—	—	100	90 to 100	20 to 55	0 to 15	—	0 to 5	—	—	—
467	1½ to No. 4 (37.5 to 4.75 mm)	—	—	—	—	100	95 to 100	—	35 to 70	—	10 to 30	0 to 5	—	—
5	1 to ½ in. (25 to 12.5 mm)	—	—	—	—	—	100	90 to 100	20 to 55	0 to 10	0 to 5	—	—	—
56	1 to 3/8 in. (25 to 9.5 mm)	—	—	—	—	—	100	90 to 100	40 to 85	10 to 40	0 to 15	0 to 5	—	—
57	1 in. to No. 4 (25 to 4.75 mm)	—	—	—	—	—	100	95 to 100	—	25 to 60	—	0 to 10	0 to 5	—
6	¾ to 3/8 in. (19.0 to 9.5 mm)	—	—	—	—	—	—	100	90 to 100	20 to 55	0 to 15	0 to 5	—	—
67	¾ in. to No. 4 (19.0 to 4.75 mm)	—	—	—	—	—	—	100	90 to 100	—	20 to 55	0 to 10	0 to 5	—
7	½ in. to No. 4 (12.5 to 4.75 mm)	—	—	—	—	—	—	—	100	90 to 100	40 to 70	0 to 15	0 to 5	—
8	3/8 in. to No. 8 (9.5 to 2.36 mm)	—	—	—	—	—	—	—	—	100	85 to 100	10 to 30	0 to 10	0 to 5

5.4 Lightweight Aggregates

5.4.1 Types

5.4.1.1 Three general types of lightweight aggregates are covered by this Standard as follows:

a) Aggregates prepared by expanding, calcining, or sintering products such as blast-furnace slag, clay, diatomite, fly ash, perlite, shale, slate, or vermiculite,

b) aggregates prepared by processing natural materials, such as pumice, scoria, or tuff, and,

c) aggregates consisting of end products of coal or coke combustion.

5.4.1.2 The aggregates shall be composed predominantly of lightweight cellular and granular inorganic material.

5.4.2 Uses

a) Lightweight aggregate can be used for making structural concrete, concrete masonry units and insulating concretes.

b) This Standard specifies the requirements of lightweight aggregate used in concrete masonry units.

c) For specification of lightweight aggregate used in structural concrete refer to IPS-M-CE-165 and also ASTM C330.

d) The lightweight aggregate used in insulating concrete consists of two groups (see ASTM C 332). Group I contains perlite and vermiculite and Group II contains pumice, scoria, and tuff (see green tuff in Clause 6.6 of this Standard).

5.4.3 Sampling

Sampling of aggregates should be in accordance with ASTM D75-87.

5.4.4 Grading

5.4.4.1 Grading of lightweight aggregate for masonry units shall conform to the requirements of Table 4 except as provided in 5.4.4.3.

5.4.4.2 Uniformity of grading

To assure reasonable uniformity in the gradation of successive shipments of lightweight aggregate, fineness modulus shall be determined on samples taken from shipments at intervals stipulated by the Purchaser. If the fineness modulus of the aggregates in any shipment differs by more than 7% from that of the sample submitted for acceptance tests, the aggregates in the shipment shall be rejected, unless it can be demonstrated that it will produce concrete of the required characteristics.

5.4.4.3 Waiver of grading requirements

When special characteristics of concrete masonry units are required, such as particular texture, strength, weight, acoustical, or thermal insulating property, the grading requirements may be waived upon agreement between the interested parties, provided the alternative grading will produce concrete of the required characteristics.

TABLE 4 - GRADING REQUIREMENTS FOR LIGHTWEIGHT AGGREGATES FOR CONCRETE MASONRY UNITS

SIZE DESIGNATION	PERCENTAGES (BY WEIGHT) PASSING SIEVES HAVING SQUARE OPENINGS							
	(19.0 mm)	(12.5 mm)	(9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18 mm)	No. 50 (300 µm)	No. 100 (150 µm)
Fine aggregate:								
No. 4 (4.75 mm) to 0	—	—	100	85 - 100	—	40 - 80	10 - 35	5 - 55
Coarse aggregate:								
1/2 in. to No. 4 (12.5 to 4.75 mm)	100	90 - 100	40 - 80	0 - 20	0 - 10	—	—	—
3/8 in. to No. 8 (9.5 to 2.36 mm)	—	100	80 - 100	5 - 40	0 - 20	0 - 10	—	—
Combined fine and coarse aggregate:								
1/2 in. (12.5 mm) to 0	100	95 - 100	—	50 - 80	—	—	5 - 20	2 - 15
3/8 in. (9.5 mm) to 0	—	100	90 - 100	90 - 100	35 - 65	—	10 - 25	5 - 15

5.4.5 Deleterious substances

Lightweight aggregates shall not contain excessive amounts of deleterious substances, as determined by the following limits:

5.4.5.1 Organic impurities (Test Method ASTM C40)

Lightweight aggregates that, upon being subjected to the test for organic impurities, produce a color darker than the Standard shall be rejected, unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

5.4.5.2 Staining (Test Method ASTM C641)

Lightweight aggregates that, upon being subjected to the test for staining materials, are classified as "heavy stain" or darker by the visual staining test, shall be tested by the chemical procedure, and aggregates that contain 1.5 mg or more of ferric oxide (Fe_2O_3) shall be rejected for use in masonry units.

5.4.5.3 Loss on ignition (Method ASTM C114)

Loss on ignition of aggregates, consisting of end products of coal or coke combustion, shall not exceed 12%. Loss on ignition of other aggregates shall not exceed 5%.

Note:

Certain processed aggregates may be hydraulic in character and may be partially hydrated during production; if so, the quality of the product is not reduced thereby. Other aggregates may, in their natural states, contain innocuous carbonates or water of crystallization, which will contribute to the loss on ignition. Therefore, consideration should be given to the type of material when evaluating the product in terms of ignition loss.

5.4.6 Clay lumps

The amount of clay lumps shall not exceed 2% by dry weight (ASTM C142).

5.4.7 Unit weight (Test Method ASTM C29-78)

Unit weight of lightweight aggregates shall conform to the requirements of Table 5. The reported unit weight of lightweight aggregate shipments sampled and tested, shall not differ by more than 10% from that of the sample submitted for acceptance tests.

TABLE 5 - UNIT WEIGHT REQUIREMENTS OF LIGHTWEIGHT AGGREGATES FOR CONCRETE MASONRY UNITS

SIZE DESIGNATION	DRY LOOSE WEIGHT, max. (kg/m³)
Fine aggregate	1120
Coarse aggregate	880
Combined fine and coarse aggregate	1040

5.5 Heavyweight Aggregates

These include magnetite with a specific gravity "δ" of 4.3, barite, $\delta = 4.2$, limonite, $\delta = 3.8$, ferrophosphorus, $\delta = 6.3$, and steel shot or purching, $\delta = 7.6$.

Such heavy weight aggregates may be used instead of gravel or crushed stone to produce a dense concrete; for example, for shielding of nuclear reactors.

6. BUILDING STONE

6.1 General

6.1.1 Building stone shall include stone that is sawed, cut, split, or otherwise finished or shaped, and also crushed and broken.

6.1.2 Stone, in general, makes and excellent building material if properly selected on the basis of experience, but the cost may be relatively high. Properties of stone depend on what nature has provided.

6.1.3 The building stones are classified as follows:

a) Granite
b) Marble
c) Limestone
d) Sandstone
e) Green tuff

This Standard specifies the requirements of building stones in accordance with ISIRI 618-1364.

6.1.4 Existence and quality of cracks in blocks will be determined by visual inspection. Hidden cracks in granites, marble and condensed limestone blocks will be determined by knocking with hammer on blocks placed over wooden plates, which will produce blunt sound if such cracks are present.

6.1.5 Storage

Stone should be carefully stored in similar order to avoid double handling. It should be stored clear of the ground to prevent the leaching of soil salts into it, or staining from moisture. In wintry weather, precautions should be taken to prevent damage to the stones through the freezing of rainwater or residual quarry-sap by covering with tarpaulins or polythene over the more normal coverings of straw, hessian or other suitable materials, which should contain nothing that might injure or stain the stone.

6.2 Granite Stone

6.2.1 Classification

6.2.1.1 Granite stone is a visible granular, igneous rock generally ranging in color from pink to light or dark gray and consisting mostly of quartz and feldspars.

6.2.2 Properties

6.2.2.1 Granite supplied under this Standard shall conform to the physical requirements prescribed in Table 6.

6.2.2.2 Granite shall be sound, durable, and free of imperfections such as starts, cracks, and seams that would impair its structural integrity.

6.2.2.3 Granite shall be free of minerals that may cause objectionable staining under normal environments of use.

6.2.2.4 The desired color and the permissible natural variations in color and texture shall be specified by careful detailed description or naming granite having the required characteristics.

TABLE 6 - PROPERTIES OF GRANITE BUILDING STONE

PROPERTY	UNIT	REQUIREMENTS	TEST METHOD
Absorption max [1)]	wt%	0.4	ISIRI 578
Density min [2)]	g/cm³	2.56	ASTM C97
Compressive strength [3)]	MPa (kg/cm²)	70 - 340 (700 - 3400)	ISIRI 617
Modulus of rupture [4)]	MPa (kg/cm²)	8 - 26 (81 - 264)	ISIRI 617
Resistance to freezing and thawing	Cycle	35	ISIRI 578

1) Maximum permissible value of water absorption by weight shall be 8%.
2) Minimum permissible value of density shall be 1.8 g/cm³.
3) Minimum permissible value of compressive strength shall be 100 MPa (1000 kg/cm²).
4) Minimum permissible value of modulus of rupture shall be 15 MPa (150 kg/cm²).

6.3 Marble Stone

6.3.1 Classification

6.3.1.1 Marble is a crystalline rock composed predominantly of one or more of the following minerals: calcite, dolomite, serpentine or travertine and capable of taking a polish.

Most marbles posses an interlocking texture and a range of grain size from cryptocrystalline to 5 mm.

6.3.2 Properties

6.3.2.1 Marble shall conform to the physical requirements prescribed in Table 7.

6.3.2.2 Marble for exterior use shall be sound, free of spalls, cracks, open seams, pits, or other defects that would impair its strength, durability or appearance.

TABLE 7 - PROPERTIES OF MARBLE BUILDING STONE
(I: CALCITE, II: DOLOMITE, III: SERPENTINE, IV: TRAVERTINE)

PROPERTY	UNIT	REQUIREMENT	CLASSIFICATION	TEST METHOD
Absorption by weight, max. [1)]	wt %	0.2 [1)]	I, II, III, IV	ISIRI 578
Density, min. [2)]	g/cm³	2.59 2.8 2.69 2.30	I II III IV	ASTM C97 (Ref.: ASTM C503)
Compressive strength [3)]	MPa (kg/cm²)	70 - 360 (700 - 3600)	I, II, III, IV	ISIRI 617
Modulus of rupture [4)]	MPa (kg/cm²)	10 - 25 (100 - 250)	I, II	ISIRI 617
Resistance to freezing and thawing	Cycle	35	III	ISIRI 578

1) Maximum permissible value of water absorption by weight shall be 8% weight.

2) Minimum permissible value of density shall be 1.8 g/cm³.

3) Minimum permissible value of compressive strength shall be 80 MPa (800 kg/cm²) for white and black marble and 60 MPa (600 kg/cm²) for colored marble.

4) Minimum permissible value of modulus of rupture shall be 10 MPa (102 kgf/cm²).

6.4 Limestone

6.4.1 Classification

6.4.1.1 Limestone is a sedimentary rock composed principally of calcium carbonate (the mineral calcite) or the double carbonate of calcium or magnesium (the mineral dolomite) or mixture of the two.

6.4.1.2 Building limestone may be classified into three categories generally descriptive of those limestones having densities in approximate ranges, as follows:

I) Low Density: Limestone having a density ranging from 1760 through 2160 kg/m³
II) Medium Density: Limestone having a density ranging from 2160 through 2560 kg/m³
III) High Density: Limestone having a density greater than 2560 kg/m³

6.4.2 Properties

6.4.2.1 Limestone supplied under this Standard shall conform to the physical requirements listed in Table 8.

6.4.2.2 Limestone shall be sound, durable, and free of visible defects or concentrations of materials that will cause objectionable staining or weakening under normal environments of use.

TABLE 8 - PROPERTIES OF LIMESTONE BUILDING STONE

PROPERTY	UNIT	REQUIREMENT	CLASSIFICATION	TEST METHOD
Absorption by weight, max. [1)]	wt %	15 - 25	I, II, III	ISIRI 578
Density, min. [2)]	g/cm³	1.760 2.160 2.560	I II III	ASTM C97 (Ref.: ASTM C568)
Humidity (max. permissible value)	wt %	5	I, II, III	ISIRI 578
Compressive strength [3)]	MPa (kg/cm²)	20 - 25 (200 - 250)	I, II, III	ISIRI 617
Modulus of rupture min. [4)]	MPa (kg/cm²)	2.7 - 35 (27 - 353)	I, II, III	ISIRI 617
Resistance to freezing and thawing	Cycle	25 - 65	I, II, III	ISIRI 578

1) Minimum permissible value of water absorption by weight shall be 8%.

2) Minimum permissible value of density shall be 1.8 g/cm³.

3) Minimum permissible value of compressive strength shall be 5 MPa (50 kgf/cm²) for porous limestone and 20 MPa (200 kgf/cm²) for condense limestone.

4) Minimum permissible value of modulus of rupture shall be 4 MPa (41 kgf/cm²).

6.5 Sandstone

6.5.1 Classification

Building sandstone shall be classified according to the free silica content as follows:

I) Sandstone, with 60% minimum free silica content.
II) Quartzite, with 90-95% minimum free silica content.

6.5.2 Properties

Sandstone supplied under this Standard shall conform to the physical requirements of Table 9.

TABLE 9 - PROPERTIES OF SANDSTONE BUILDING STONE

PROPERTY	UNIT	REQUIREMENT	CLASSIFICATION	TEST METHOD
Absorption by weight, max. [1)]	wt%	0.4	I, II	ISIRI 578
Density, min. [2)]	g/cm³	2.16 2.56	I II	ASTM C97 (Ref.: ASTM C568)
Humidity (max. permissible value)	wt %	5	I, II	ISIRI 578
Compressive strength [3)]	MPa (kg/cm²)	30 - 270 (300 - 2700) 300 - 420 (3000 - 4200)	I II	ISIRI 617
Modulus of rupture min. [4)]	MPa (kg/cm²)	4 - 24 (41 - 244) 8 - 43 (81 - 434)	I II	ISIRI 617

1) See Note 1 of Table 8.

2) See Note 2 of Table 8.

3) Minimum permissible value of compressive strength shall be 20 MPa (200 kg/cm²) for Type I and 200 MPa (2000 kg/cm²) for type II.

4) Minimum permissible value of modulus of rupture shall be 4 MPa (41 kg/cm²) for Type I and 20 MPa (200 kg/cm²) for Type II.

6.6 Green Tuff

6.6.1 Properties

6.6.1.1 The great thickness and vast spread of green tuffs reveals the importance of such stones in the economy of our country.

6.6.1.2 From geological point of view, green tuffs are submarine volcanic rocks. While quartz and then feld-spars are the most common minerals.

6.6.1.3 Green tuff supplied under this Standard shall conform to the physical requirements listed in Table 10.

Note:

For more information about green tuffs see "Properties and Application of Alborz Green Tuffs" Pub 1. No. 115 - (1369), Building and Housing Research Center, Ministry of Housing and Urban Development.

TABLE 10 - PROPERTIES OF GREEN TUFF

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Absorption by weight, max. [1)]	wt%	0.4	ISIRI 578
Density [2)]	g/cm³	2.15 - 2.5	ASTM C97
Compressive strength [3)]	MPa (kg/cm²)	55 - 110 (550 - 1100)	ISIRI 617
Modulus of rupture	MPa (kg/cm²)	13 - 43 (134 - 432)	ISIRI 617
Resistance to freezing and thawing	Cycle	15	ISIRI 578
Soundness (five cycle) [4)]	wt %	3 - 15	ASTM C88
Abrasion resistance [5)] (1000 cycle)	wt %	10 - 16	ISIRI 448
Humidity [6)]	wt %	0.1 - 0.8	ISIRI 578

1) See Note 1, Table 8.
2) See Note 2, Table 8.
3) Minimum permissible value of compressive strength shall be 5 MPa (50 kgf/cm^2).
4) Maximum permissible value of soundness shall be 30% of weight.
5) Maximum permissible value of abrasion resistance shall be 30% of weight.
6) Maximum permissible value of humidity shall be 5% of weight.

7. CLAY BRICKS

7.1 General

7.1.1 The bricks are manufactured from clay, shale or similar naturally occurring earthy substances and subjected to a heat treatment at elevated temperatures (firing). The heat treatment must develop a fired band between the particulate constituents to provide the property requirements of this Standard.

7.1.2 This clause of the Standard specifies requirements for dimension, compressive strength, water absorption, soluble salt content, efflorescence and sampling for bricks manufactured from clay.

7.1.3 The standard method of sampling and testing bricks is in accordance with ISIRI 7 or ASTM C 67-87.

7.1.4 The specification of clay used for making bricks shall be in accordance with ISIRI 1162.

7.1.5 The brick shall be free of defect, deficiencies and surface treatment, including coating that would interfere with the proper setting of the brick or significantly impair the strength or performance of the construction.

7.1.6 Unless otherwise specified by AR* bricks shall be either solid or cored at the option of the manufacturer.

7.1.7 The efflorescence of the bricks would be classified into the following categories:

a) Nil - No perceptible deposit of salts.

b) Slight - Up to 10% of the area of the face covered with a deposit of salts, but unaccompanied by powdering or flaking of the surface.

c) Moderate - More than 10% but not more than 50% of the area of the face covered with a deposit of salts, but unaccompanied by powdering or flaking of the surface.

d) Heavy - More than 50% of the area of the face covered by a deposit of salts and/or powdering or flaking of the surface.

7.1.8 Bricks are classified as follows:

a) Engineering brick

A class of brick used wherever strength and appearance are essential; e.g. for the faces of abutments, piers, and arches. They are machine made and may have "frogs" on one or both of the larger sides.

b) Facing brick

A class of brick used for ordinary facing work; of better quality and appearance than common bricks, but not made to withstand heavy loads, as are engineering bricks. Facing bricks are either machine made, pressed or hand made.

*** AR = Authorized Representative of the Owner.**

c) Common brick

A class of brick used in ordinary construction (especially in interior work) for filling in, and to make up the requisite thickness of heavy walls and piers. They are much more absorbent and also much weaker than engineering bricks. Common bricks are either machine made or hand made.

Note:

Selection of locations where one of the above brick types should be installed will be done by the AR.

7.2 Engineering Brick

7.2.1 Sampling

Sampling of engineering bricks should be in accordance with ISIRI 7.

7.2.2 Sizes

Bricks shall be designated in terms of their coordinating sizes. The coordinating size in accordance with test method ISIRI 7. Clause 5.1, shall be as given in Table 11.

TABLE 11 - SIZES OF ENGINEERING BRICKS

DIMENSION (mm)	REQUIREMENT (TOLERANCE)
Length	220 ±2
Width	105 ±1
Height	55 ±1

7.2.3 Properties

Engineering bricks supplied under this Clause shall conform to the requirements prescribed in Tables 12 and 13.

TABLE 12 - PROPERTIES OF ENGINEERING BRICK

PROPERTY	CLASSES	UNIT	REQUIREMENT	TEST METHOD
Compressive strength (min.)	Class 1 Class 2 Class 3	MPa (kg/cm²)	35 (350) 25 (250) 15 (150)	ISIRI 7 (Clause 5.3)
Water absorption (max.) [1)]	Class 1 Class 2 Class 3	wt %	15 16 18	ISIRI 7 (Clause 5.4)
Efflorenscence (max.)	All classes	grade [2)]	Slight	ISIRI 7 (Clause 5.5)
Frost resistance (max.)	Class 1 Class 2 Class 3	wt % loss	NR [3)] NR 3	ISIRI 7 (Clause 5.7)
Convexity and concavity (max.)	Class 1 Class 2 Class 3	mm	0.5 1 1	ISIRI 7 (Clause 5.2)

1) With boiling or vacuum test method.

2) See clause 7.1.7.

3) NR: This test is not required.

TABLE 13 - SOLUBLE SALT CONTENT OF ENGINEERING BRICKS (in accordance with ISIRI 7 - Clause 5.6)

ENGINEERING BRICK	MAXIMUM PERMISSIBLE VALUE OF SOLUBLE SALT CONTENT (WT%)			
	SULFATE	CALCIUM	MAGNESIUM	SODIUM & POTASSIUM
Class 1	0.5	0.3	0.03	0.06
Class 2	0.5	0.3	0.03	0.06
Class 3	0.6	0.6	0.6	0.6

7.3 Facing Brick

7.3.1 Sampling

Sampling of facing bricks should be in accordance with ISIRI 7.

7.3.2 Sizes

Size and tolerance of facing bricks in accordance with test method ISIRI 7. Clause 5.1, shall be as given in Table 14.

TABLE 14 - SIZES AND TOLERANCE OF FACING BRICKS

DIMENSION (mm)	Thickness = 55 mm			Thickness = 40 mm		Thickness = 30 mm	
	Machine made	Pressed	Hand made	Machine made	Hand made	Machine made	Hand made
Length	220 ±2	220 ±3	210 ±3	220 ±2	210 ±3	220 ±2	210 ±3
Width	105 ±1	105 ±1.5	100 ±1.5	105 ±1	100 ±1.5	105 ±1	100 ±1.5
Thickness	55 ±1	55 ±1.5	55 ±1.5	40 ±1	40 ±1.5	30 ±1	30 ±1.5

7.3.3 Properties

Facing bricks supplied under this Clause shall conform to the requirements prescribed in Table 15.

TABLE 15 - PROPERTIES OF FACING BRICKS

PROPERTY	CLASSES	UNIT	REQUIREMENT	TEST METHOD
Compressive strength (min.)	Class 1 Class 2	MPa (kg/cm²)	12 (120) 10 (100)	ISIRI 7 (Clause 5.3)
Water absorption (max.) [1)]	Class 1 Class 2	wt %	20 23	ISIRI 7 (Clause 5.4)
Efflorenscence (max.)	Class 1 Class 2	grade [2)]	Slight Moderate	ISIRI 7 (Clause 5.5)
Frost resistance (max.)	Class 1 Class 2	wt % loss	NR [3)] 3	ISIRI 7 (Clause 5.7)
Convexity and concavity (max.)	Class 1 Class 2	mm	1 2	ISIRI 7 (Clause 5.2)
Soluble salt content (max.)	Class 1 Class 2	wt %	0.6 0.6	ISIRI 7 (Clause 5.6)

1) With boiling or vacuum test method. **2) See clause 7.1.7.** **3) NR - This test is not required.**

7.4 Common Brick (for Interior Work)

7.4.1 Sampling

Sampling of common bricks should be in accordance with ISIRI 7.

7.4.2 Size and tolerance of common bricks in accordance with test method ISIRI 7. Clause 5.1 shall be as given in Table 16.

TABLE 16 - SIZES OF COMMON BRICKS

DIMENSION (mm)	MACHINE AND SEMI-MACHINE MADE	HAND MADE
Length	200 ±3	210 ±5
Width	105 ±1.5	100 ±2.5
Thickness	55 ±1.5	55 ±2

7.4.3 Properties

Common bricks supplied under this Clause shall conform to the requirements prescribed in Table 17.

TABLE 17 - PROPERTIES OF COMMON BRICKS

PROPERTY	USES	UNIT	REQUIREMENT	TEST METHOD
Compressive strength (min.)	1) Interior load bearing wall 2) Non-load bearing wall	MPa (kg/cm²)	6 (60) 4 (40)	ISIRI 7 (Clause 5.3)
Water absorption (max.)	—	—	NR [1)]	ISIRI 7 (Clause 5.4)
Efflorenscence (max.) [2)]	—	grade [2)]	Moderate	ISIRI 7 (Clause 5.5)
Frost resistance (max.)	—	wt % loss	NR [1)]	ISIRI 7 (Clause 5.7)
Convexity and concavity (max.)	—	mm	NR [1)]	ISIRI 7 (Clause 5.2)
Soluble salt content (max.)	—	wt %	NR [1)]	ISIRI 7 (Clause 5.6)

1) NR - This test is not required.
2) See clause 7.1.7.

8. GYPSUM AND GYPSUM PRODUCTS

8.1 General

8.1.1 The dehydrate of calcium sulfate, $CaSO_4$. $2H_2O$ is the raw material from which the gypsum plasters are commonly manufactured.

8.1.2 Gypsum plaster is hemihydrated calcium sulfate $CaSO_4$. ½ H_2O. and used for building in forms of powder and board.

8.1.3 The specification of gypsum building plaster and the test methods are in accordance with ISIRI 269 and for gypsum wall board are in accordance with ISIRI 2786.

8.1.4 Handling and storage

- Store bags of gypsum in dry, weatherproof, enclosed shed or building with a dry floor. If the floor is concrete, store on a timber platform.

- Stack bags away from walls, close to each other not more than eight bags high.

- In the case of small quantities for immediate use, if not stored in a shed or building, stand the bags on a timber platform, well clear of the ground and cover with polyethylene sheet so that all the bags are wholly protected from wind and rain.

- Do not let gypsum wall board get wet. If practicable keep it in the wrapping in which it was delivered.

- Carry boards on edge; pick them up and place them down on edge to avoid breakage when laying flat.

- Do not drag boards over each other.

- If slings are used for lifting, stack boards on a clean, dry platform so that they do not overhang. Keep slings away from the board edges by using spreaders to avoid damage to the edge.

- If transporting boards by damper, crane or fork-lift truck, use a supporting platform.

- Store boards off the ground and horizontally on a level base consisting of a timber platform or bearers at least 100 mm wide laid across the width of the boards at centers not exceeding 400 mm. If it is not stored in a weatherproof building, completely cover the stack with a weatherproof sheet secured all round. Protect from damp rising from below the stack. Unless special provisions are made, do not stack boards to a height of more than 1 m.

8.2 Gypsum Plaster

8.2.1 Gypsum plaster is produced by heating of gypsum rock ($CaSO_4.2H_2O$) at specified temperature, and is used in building work. Gypsum plaster consists of calcined gypsum, having the ability, when mixed with water, to produce a plastic mortar or slurry which can be formed to the desired shape by various methods and will subsequently set to a hard, rigid mass.

8.2.2 Classification

Gypsum plaster is manufactured in two grades for different uses:

a) Base coat plaster, used for first layer applied over substrata;
b) final coat plaster, used for final layer applied over base coat plaster.

8.2.3 Properties

Gypsum plaster shall comply with the requirements of Tables 18 and 19 when sampled and tested by the methods described in ISIRI 269.

TABLE 18 - PROPERTY REQUIREMENTS FOR GYPSUM BUILDING PLASTER

	Grading		Initial setting time (min.)	Final setting time (min.)	Compressive strength kg/cm²	Modulus of rupture kg/cm²
Undercoat Plaster	**Sieve Size (mm)**	**Retained Over Sieves wt %**	4 to 8	10 to 15	min. 70	min. 25
	2.50 1.40 0.5	• max. 5 8 to 15				
Finish coat plaster	2.5 1.4 0.5 0.25	• • • max. 2	4 to 8	10 to 15	min. 70	min. 25

TABLE 19 - CHEMICAL PROPERTY OF GYPSUM PLASTER

COMPOSITION		PERMISSIBLE AMOUNT wt%
1. Sulfur-Trioxide	(SO_3)	min. 36
2. Calcium Oxide	(CaO)	min. 24
3. Sodium Oxide	(Na_2O)	max. 0.3
4. Magnesium Oxide	(MgO)	max. 0.6
5. Combined Water	(H_2O)	max. 6

8.3 Prefabricated Gypsum Wall Board

8.3.1 The gypsum wall boards are sheet products consisting of a noncombustible core primarily of gypsum, used as a vertical or horizontal surfacing for interior building structure.

The gypsum plaster board is manufactured to receive either direct surface decoration or gypsum plaster finishes.

8.3.2 Composition

Gypsum wall board is manufactured by calcined gypsum (see Clause 8.2) with addition of light weight aggregate (see Clause 5.4) and additives. The aggregates and additives shall not contain excessive amounts of deleterious materials which produce efflorescence on boards.

8.3.3 Density

Density of gypsum wall board is the ratio of weight to visual volume of board. Density of various types of wall board is described in Table 20 in accordance with ISIRI 2786.

TABLE 20 - DENSITY[1)] OF PREFABRICATED GYPSUM WALL BOARD

TYPES OF PREFABRICATED GYPSUM BOARD	DENSITY g/cm³
Porous type	0.7
Class 1	0.7 - 0.9
Class 2	0.9 - 1.2

1) The samples shall be dried to constant weight in 40 ±2 degrees of centigrade.

8.3.4 Breaking load (modulus of rupture)

The average breaking load of 3 samples, when tested in the manner described in ISIRI 2786, Clause 5.4 shall be not less than 10 MPa (100 kgf/cm²). Additionally no individual load for each sample shall be less than 8 MPa (80 kgf/cm²).

8.3.5 Dimensions and weight

The dimensions and weight of prefabricated gypsum wall boards are shown in Table 21.

TABLE 21 - DIMENSIONS AND WEIGHT OF PREFABRICATED GYPSUM WALL BOARDS

DIMENSIONS (mm)			MAXIMUM WEIGHT (kg)		
THICKNESS +2 -1	LENGTH +3 -1	WIDTH +2 -1	DENSITY ½ g/cm³	DENSITY 0.9 g/cm³	DENSITY 0.7 g/cm³
60	666	500	24	18	14
70	666	500	28	21	16
80	666	500	32	24	18.7
100	666	500	—	30	23.4
120	666	500	—	—	28

9. BLOCKS AND TILES (UNGLAZED)

9.1 General

9.1.1 This Clause of the Standard specifies requirements for the following types of blocks and unglazed tiles:

- **a)** Cement blocks.
- **b)** Ordinary prefabricated joists.
- **c)** Roofing filler blocks.
- **d)** Terrazzo tiles.

9.1.2 The specification and test methods of cement blocks are in accordance with ISIRI 70. Specifications for filler joists and blocks are in accordance with ISIRI 2909 and for terrazzo tiles are in accordance with ISIRI 755.

9.2 Cement Blocks

9.2.1 Composition

9.2.1.1 This Section of the Standard covers cement blocks made from Portland cement (ISIRI Specifications 389 to 394), water (ISIRI Specification 70) and suitable coarse and fine aggregates (ISIRI Specifications 300 and 302 and Clause 5 of this Standard).

The concrete mixture shall consist of one part Portland cement and six parts aggregate (3.5 part coarse aggregate and 2.5 part fine aggregate).

Notes:

After production the blocks shall be stored in water for 21 days.
For air drying, the blocks shall be stored in shade for 28 days.

9.2.2 Uses

Cement blocks manufactured in accordance with this Standard, shall be used as architectural veneer and facing units in exterior walls and where moderate strength and resistance to moisture penetration and frost action are required.

9.2.3 Dimensions and permissible variations

9.2.3.1 Dimensions of cement blocks shall be according with Table 22.

9.2.3.2 Permissible variation for height and width is ±1.5 mm and for length is ±3 mm.

9.2.3.3 Cement blocks shall contain hollow spaces (cells) which are enclosed within the perimeter of the exterior shells.

Dimension of hollow spaces shall not exceed $^{2}/_{3}$ overall dimension of block, and cross section area of hollow spaces shall not exceed 50% of overall cross section area.

9.2.3.4 Shell and web thickness of blocks shall not be less than 40 mm for large and medium sizes and 30 mm for the small size.

TABLE 22 - DIMENSIONS OF CEMENT BLOCK

SIZES	STANDARD DIMENSIONS mm			NOMINAL DIMENSIONS mm		
	Height	Width	Length	Height	Width	Length
Large	190	300	390	200	300	400
Medium	190	200	390	200	200	400
Small	190	100	390	200	100	400

9.2.4 Sampling and testing

Sampling and testing of cement blocks should be in accordance with ISIRI 70 and ASTM C140.

9.2.5 Physical properties

Average compressive strength (in accordance with ISIRI 70 - Section 4) for 3 samples shall not be less than 280 kg for each cm^2 of solid surface.

9.2.6 Visual inspection

All cement blocks shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or impair the strength or stability of the construction.

9.3 Ordinary Prefabricated Joists

9.3.1 Description

Ordinary prefabricated joists shall be made of concrete and steel bar with or without clay cast.

9.3.2 Material specification

Prefabricated joists shall be made of Portland cement, aggregate, water, reinforcement bars, in accordance with the following specifications:

a) Portland cement: ISIRI 389
b) Fine aggregate: Section 6 of this Standard
c) Coarse aggregate: Section 6 of this Standard
d) Water: ISIRI 1900-3
e) Admixture: BS 5896
f) Reinforcement bars: Part 2 of this Standard

9.3.3 Composition

Quality of cement used for making ordinary joists shall not be less than 250 kg/m³.

9.3.4 Dimensions

Dimensions of ordinary prefabricated joists shall be in accordance with Table 23.

TABLE 23 - DIMENSIONS OF ORDINARY PREFABRICATED JOISTS

DIMENSION	REQUIREMENT
Bottom width (min.)	100 mm
Height (max.)	3.5 times of its width
Toe concrete thickness (min.) (without clay cast)	45 mm
Steel bar to bottom distance (min.)	18 mm

9.3.5 Sampling

Sampling and testing of ordinary joist shall be in accordance with ISIRI 2909. The compressive strength of joist after 28 days shall not be less than 25 MPa (250 kg/cm²).

9.3.6 Visual inspection

Concrete surfaces and edges of joist shall be sound and free of cracks or other defects.

9.4 Roofing Filler Blocks

9.4.1 Concrete filler blocks

9.4.1.1 Composition

Concrete filler blocks shall be made of cement, aggregate and water.

The specification of material used for making concrete filler blocks shall be in accordance with sub-clause 9.3.1.2.

9.4.1.2 Dimension and tolerances

Dimension and tolerances of concrete filler blocks shall be in accordance with Table 24.

9.4.1.3 Sampling

Sampling and testing of concrete block should be in accordance with ISIRI 2909.

TABLE 24 - SIZE AND TOLERANCE OF CONCRETE FILLER BLOCKS

DIMENSIONS	REQUIREMENTS
Width tolerances (max.)	±2 mm
Length and height tolerances (max.)	±5 mm
Shell and web thickness (min.)	18 mm
Supporting width (min.)	17.5 mm

9.4.2 Clay filler blocks

9.4.2.1 Description

Blocks shall be made of clay, with or without admixture, burned in furnace to meet the requirements of this Standard. Material used for making clay blocks shall be in accordance with ISIRI 1162.

9.4.2.2 Dimensions

Dimensions and tolerances of clay filler blocks shall be in accordance with Table 25.

9.4.2.3 Sampling

Sampling and testing of clay filler blocks shall be in accordance with ISIRI 2909 and ISIRI 7.

9.4.2.4 Visual inspection

The body of blocks shall be free of cracks. For the ease of bonding to plaster-base finish the exterior surface of clay block shall be grooved.

TABLE 25 - DIMENSIONS AND TOLERANCES OF CLAY FILLER BLOCKS

DIMENSIONS	REQUIREMENTS
Width tolerances (max.)	±4 mm
Length and height tolerances (max.)	±5 mm
Shell and web thickness (min.)	18 mm
Supporting width (min.)	17.5 mm
Distances between center of two joists used with clay filler blocks	600 mm

9.5 Terrazzo Tiles

9.5.1 This Clause of the Standard specifies requirements for hydraulically-pressed terrazzo floor tiles for interior and exterior of buildings. Terrazzo tiles consists of two layers, i.e. facing and base layers.

9.5.2 Layers of terrazzo tiles

9.5.2.1 Facing layer is the external surface of terrazzo tiles and consists of aggregate, cement and pigment. The aggregate shall consist of good quality marble, or other natural stone with similar characteristics of adequate hardness. The approximate sizes of marble aggregates shall correspond to commercial grades of 2 mm to 50 mm. The facing layer shall be such as to provide a minimum wearing thickness of 6 mm after grinding.

9.5.2.2 Base layer is the internal surface of terrazzo tiles and consists of fine aggregate and cement. The aggregate shall consist of naturally occurring material, such as crushed or uncrushed gravel, or crushed stone with natural sand, crushed stone sand or crushed gravel sand.

The base layer shall consist of not less than 3 and not more than 3½ parts of aggregate to one part of cement proportioned by weight.

9.5.3 Shape

Tiles shall be square with flat tops and of rectangular cross-section.

9.5.4 Dimensions

The dimensions of square tiles shall be as given in Table 26.

The thickness of tiles shall not be less than the amount shown in Table 26.

Maximum tolerances of length shall be 2 mm and that of thickness shall be 6% of thickness.

TABLE 26 - SIZES OF TERRAZZO TILES

LENGTH × WIDTH (mm)	Minimum Thickness (mm)
100 × 100	7
150 × 150	10.5
200 × 200	14
250 × 250	17.5
300 × 300	21
400 × 400	28
500 × 500	35

9.5.5 Freedom from defects or flaws

- The aggregate shall be evenly distributed;

- the face shall be free from projections, depressions, flakes and crazes;

- the edges of the tile shall be perpendicular to the surface. The planes of the upper and lower surfaces of the tile shall be parallel and adjacent vertical edges of square tiles shall be at right angles to each other;

- all arrises shall be sharp and true.

9.5.6 Uniformity of color

The overall color of tiles shall be generally uniform in any one delivery, except where special random effects are ordered.

9.5.7 Age at testing and delivery

The minimum age at testing shall be 28 days. The minimum period between pressing and delivery shall be 21 days to 28 days.

9.5.8 Sampling and testing

The sampling and testing of tiles shall be in accordance with ISIRI 755.

9.5.9 Water absorption

Water absorption of sample when tested by the method of ISIRI 755 Clause 8, shall not be more than 10% per sample.

9.5.10 Frost resistance

Frost resistance shall be tested in accordance to ISIRI 755, Clause 8. No cracks shall be observed in sample after test.

9.5.11 Erosion resistance

Erosion resistance of tiles shall be tested in accordance with ISIRI 755, Clause 13.

9.5.12 Modulus of rupture

The modulus of rupture of samples when tested according to ISIRI 755, Clause 8 shall not be less than the amounts indicated in Table 27.

TABLE 27 - MINIMUM MODULUS OF RUPTURE FOR TERRAZZO TILES

TILE	MINIMUM MODULUS OF RUPTURE MPa (kgf/cm²)	
	For each sample	Average of 3 samples
Tile with aggregate size 2 to 20 mm	6 (60)	7 (70)
Tiles with aggregate size 20 to more than 50 mm	5 (50)	6 (60)

10. GLASS

10.1 General

10.1.1 This Clause of the Standard specifies requirements for following types of glass:

a) Sheet glass (clear),
b) Toughened safety glass for building,
c) Wired glass,
d) Obscured glass (Frosted sheet glass),
e) Figured glass.

10.1.2 Method of storage

- Glass sheets shall be stored with a layer of paper separating them.

- All glass shall be kept dry, whether stored in crates or packed otherwise.

- Glass shall be removed from the crates carefully to avoid edge chipping, scratching and other damages.

- Glass shall be lifted and stored on its long edge and shall be put into stacks of not more than 25 panes, supported at two points by fillets of wood at about 300 mm from each end.

- A stack of panes shall be laid on wooden fillets and rested against the vertical support in such a manner that it shall be prevented from sliding or any change during storage.

- The whole stack shall be as closely packed and as upright as possible.

10.1.3 Quality

The quality of glass shall comply with the requirements specified in Table 28 and shall be tested in accordance with ISIRI 897 and JIS R 3201 to R 3204.

TABLE 28 - QUALITY OF GLASS

TYPE OF DEFECT	QUALITY
Bubble	Individual length of bubbles at central part not to exceed 25 mm and at edges not to exceed 35 mm Permissible total length of bubbles shall be less than 100 mm for one sq. meter sheets and 120 mm for larger sheets
Inclusion	Acceptable as far as not affecting serviceability
Crazing	Any crazing causing glass breakage not accepted
Chip and flare	Size of width and length not to exceed glass thickness
Warpage	0.5 % max, acceptable
Seam and wave (for sheet glass)	The vision at 60 degrees through the glass shall not be excessively distorted
Speck, clouding, scratch (only for sheet glass)	None acceptable which excessively hinder the vision through the glass
Figure imperfection (only for figured and wired glass)	No remarkable figure imperfection accepted
Exposure of net (only for wired glass)	Metallic net or wire shall be embedded in the plate glass, and not be exposed on surfaces

10.2 Sheet Glass

10.2.1 Description

Sheet glass is transparent glass manufactured by flat drawn process. Sheet glass has natural fire-finished surfaces but, because the two surfaces are never perfectly flat and parallel, there is always some distortion of vision and reflection.

10.2.2 Sampling

Sampling and testing of sheet glass shall be in accordance with ISIRI 897.

10.2.3 Dimensions

Thickness, tolerance for thickness and cutting tolerance of sheet glass shall be in accordance with Table 29.

TABLE 29 - THICKNESS AND TOLERANCES OF SHEET GLASS

NOMINAL THICKNESS mm		TOLERANCE FOR THICKNESS mm	CUTTING TOLERANCE mm	
			Sides < 2000 mm	Sides > 2000 mm
Thin sheet glass	1	±0.2	±2	±3
	2	±0.2	±2	±3
Medium sheet glass	2.2	±0.3	±2	±3
	3	±0.3	±2	±3
	4	±0.3	±3	±4
Thick sheet glass	5	±0.3	±3	±4
	5.5	±0.3	±3	±4
	6	±0.3	±3	±4
	8	±0.4	±3	±4
	10	±0.5	±4	±5
	12	±0.8	±4	±5
	15	±1.0	±4	±5

10.3 Toughened Safety Glass for Building

10.3.1 Description

Toughened glass is a safety glazing material produced by subjecting sheet glass to a process of heating and rapid cooling, which induces high compression in the surface and a compensating tension in the center. Because of this prestressing, toughened glass is less liable than annealed glass to break as a result of impact, mechanical load or thermal stress. If toughened glass should break, it will fragment into comparatively harmless pieces. Predetermined sizes are necessary because once the glass has been toughened it cannot be cut or worked.

10.3.2 Dimensions

Thickness and tolerance for thickness of toughened safety glass shall be in accordance with Table 30.

TABLE 30 - THICKNESS AND TOLERANCE OF TOUGHENED SAFETY GLASS

NOMINAL THICKNESS mm	TOLERANCES FOR THICKNESS mm
3	±0.2
4	±0.2
6	+0.2 -0.7
8	±0.4
10	±0.7
10 to 16	±0.7

10.3.3 Sampling and testing

Sampling and testing of toughened safety glass shall be in accordance with ISIRI 2385.

10.4 Wired Glass

10.4.1 Description

The wired glass is defined as the glass in which metallic net or wire is embedded in the course of fusion manufacturing. The embedded wire, however, holds the glass together and breaks only under a severe blow.

10.4.2 Types

The types according to surface texture shall be as follows:

a) Wired figured glass

The glass as fusion-manufactured, embedded with net or wire and cast with a figure on either side.

b) Wired polished plate glass

The plate glass embedded with net or wire, made from wired figured glass by polishing both sides extremely flat.

10.4.3 Dimensions

The thickness, tolerance for thickness and tolerance for length and width shall comply with Table 31.

10.4.4 Material

The wire used for the wired glass shall be of common steel or special steel, and its diameter shall be not less than 0.4 mm for common carbon steel or not less than 0.3 mm for special steel.

TABLE 31 - THICKNESS AND TOLERANCES OF WIRED SHEET GLASS

THICKNESS mm	TOLERANCE FOR THICKNESS mm	TOLERANCE FOR LENGTH AND WIDTH (mm)
6.8 10	±0.6 ±0.9	±2 +2 -3

10.4.5 Sampling

Sampling and testing of wired sheet glass shall be in accordance with BS 952.

10.5 Obscured Glass (Frosted Sheet Glass)

10.5.1 Description

Obscured or matt glass is sheet glass of which one face has been subjected to frosting by a suitable method, such as sand-blasting, etching, etc. Obscured glass is used mainly for window panes of buildings.

10.5.2 Dimensions

Thickness and tolerances thereon shall comply with Table 32.

10.5.3 Sampling

Sampling and testing of obscured glass shall be in accordance with JIS R 3201.

TABLE 32 - THICKNESS AND TOLERANCES OF OBSCURED GLASS

THICKNESS mm	TOLERANCE FOR THICKNESS mm	TOLERANCE FOR LENGTH AND WIDTH (mm)
2	±0.2	+1 -2
3	±0.3	+1 -2
5	±0.3	±2

10.6 Figured Glass (Patterned Glass)

10.6.1 Description

The figured glass is defined as the glass press-figured on either face in fusion-manufacturing state, used mainly as window panes of buildings.

10.6.2 Dimensions

Thickness and tolerance for thickness of figured glass shall be in accordance with Table 33.

10.6.3 Sampling

Sampling and testing of figured glass shall be in accordance with BS 952.

TABLE 33 - THICKNESS AND TOLERANCES OF FIGURED GLASS

NOMINAL THICKNESS mm	TOLERANCES FOR THICKNESS mm
2.2	±0.3
4.0	±0.4
6.0	±0.5

MATERIAL STANDARD

FOR

BUILDING MATERIALS

PART TWO

CONTENTS :

PAGE No.

11. GENERAL

This material Standard consists of two parts:

The first part includes specifications of following building materials:

a) Aggregates.
b) Building stone.
c) Clay bricks.
d) Gypsum and gypsum products.
e) Blocks and tiles (unglazed).
f) Glass.

The second part includes specifications of following building materials:

g) Ceramic tiles.
h) Vitreous china sanitary appliances.
i) Waterproofing materials.
j) Plastic floor covering.
k) Grating.
l) Sound adsorption tiles.
m) Paints.
n) Wooden doors and furnitures.
o) Aluminum extruded products.
p) Structural steels.

This Standard is intended to be used in oil, gas, and petrochemical industries for general building construction purposes.

12. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant/Contractor.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM A 82-88	"Specification for Steel Wire, Plain, for Concrete Reinforcement"
ASTM A 121-86	"Specification for Zinc-Coated Steel Barbed Wires"
ASTM A 184 M-88	"Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement"
ASTM A 185-85	"Specification for Steel, Welded Wire Fabric, Plain, for Concrete Reinforcement"
ASTM A 416-88 b	"Specification for Uncoated Seven-Wire Stress-Relieved Steel Strand"
ASTM A 421-85	"Specification for Uncoated Stress-Relieved Wire"
ASTM A 496-85	"Specification for Steel Wire, Deformed, for Concrete Reinforcement"
ASTM A 497-86	"Specification for Welded Deformed Steel Wire Fabric"
ASTM A 615 M-88	"Specification for Deformed and Plain Billet-Steel Bars"

ASTM A 700-81	"Practices for Packaging for Steel Products"
ASTM A 706 M-88	"Specification for Low-Alloy Steel Deformed Bars"
ASTM A 722-88	"Specification for Uncoated High-Strength Steel Bar"
ASTM A 767 M-88	"Specification for Zinc Coated Bars"
ASTM C 423-89	"Test Method for Sound Absorption by Reverberation Room Method"
ASTM D 41-85	"Specification for Asphalt Primer Used in Roofing and Waterproofing"
ASTM D 312-84	"Specification for Asphalt Used in Roofing"
ASTM D 449-83	"Specification for Asphalt Used in Dampproofing and Waterproofing"
ASTM D 1327-86	"Specification for Bitumen-Saturated Woven Burlap Fabrics Used in Roofing and Waterproofing"
ASTM F 668-88	"Specification for Polyvinyl Chloride (PVC) Coated Steel Chain-Link Fence Fabric"

BSI (BRITISH STANDARDS INSTITUTION)

BS 729, 1971	"Specification for Hot Dip Galvanized Coatings on Iron and Steel Articles"
BS 747, 1977	"Specification for Roofing Felts"
BS 1449 Part 1, 1983	"Specification for Carbon and Carbon Manganese Plate, Sheet, and Strip"
BS 2989, 1982	"Specification for Continuously Hot-Dip Zinc Coated and Iron-Zinc Alloy Coated Steel"
BS 3083, 1988	"Specification for Hot-Dip Zinc Coated and Hot-Dip Al/Zn Coated Corrugated Steel Sheets"
BS 3402, 1969	"Specification for Quality of Vitreous China Sanitary Appliances"
BS 3621, 1980	"Specification for Thief Resistance Locks"
BS 3690 Parts 1 - 3, 1982	"Specification of Bitumens"
BS 4360, 1986	"Specification for Weldable Structural Steels"
BS 4592/1, 1987	"Specification for Open Bar Gratings"
BS 4592/2, 1987	"Specification for Expanded Metal Grating Panels"
BS 4951, 1973	"Specification for Builders Hardware: Lock and Latch Furniture (Doors)"
BS 5135, 1984	"Specification for Arc Welding of Carbon and Carbon Manganese Steels"
BS-CP 144, 1970	"Roof Coverings"
BS-CP 290, 1973	"Suspended Ceilings and Linings of Dry Construction"
BS-DD-171, 1987	"Guide to Specifying Performance Requirements for Hinged or Pivoted Doors"

DIN (DEUTSCHES INSTITUT FÜR NORMUNG e.V)

Din 1024-82	"Steel Bars, Hot Rolled Round Edge T-Bars"
Din 1025-65	"Steel Sections, Hot Rolled I-Beams"
Din 1027-65	"Steel Bars, Hot Rolled Round Edge Zeds"
Din 1725-83	"Aluminum Alloys, Wrought Alloys"
Din 1748-83	"Wrought Aluminum and Aluminum Extruded Section"
Din 10034-45	"Tolerances of Dimension for Wide Flange I-Beams"
Din 18103-83	"Doors, Burglar Resistant Doors"
Din 59051-81	"Steel Bars, Hot Rolled Sharp-Edged T-bars"
Din 59200	"Hot Rolled Patterned Plate"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-C-TP-101	"Surface Preparation"
IPS-C-TP-102	"Painting"
IPS-M-TP-110	"Vinyl Paint (Aluminum) as Intermediate & Top Coat"
IPS-M-TP-115	"Red Lead Iron Oxide, Raw Linseed Oil & Alkyd Primer"
IPS-M-TP-120	"Red Lead, Iron Oxide & Alkyd Intermediate Paint"
IPS-M-TP-125	"White Alkyd Paint for Top Coat"
IPS-M-TP-130	"Colored Alkyd Paint for Top Coat Except White"
IPS-M-TP-135	"Chlorinated Rubber Paint for Top Coat"
IPS-M-TP-140	"Chlorinated Rubber Paint for Intermediate"
IPS-M-TP-145	"Chlorinated Rubber Inhibitive Primer"
IPS-M-TP-165	"Alkyd Paint (Black) as Intermediate & Top Coat"
IPS-M-TP-170	"Vinyl Paint (Black) as Intermediate & Top Coat"
IPS-M-TP-205	"Zinc-Rich Epoxy Paint (Organic Zinc-Rich) as Primer, Intermediate & Top Coat"

ISIRI (INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCH OF IRAN)

ISIRI 25-1982	"Specification and Methods for Sampling and Test for Glazed Ceramic Tile"
ISIRI 289-1976	"Specification for Emulsion Paint"
ISIRI 307-1982	"Specification of Paint for Swimming Pool and Other Concrete and Masonry Surfaces"
ISIRI 339-1968	"Specification for Traffic Paint"
ISIRI 526-1982	"Method of Test for Ready-Mixed Paints"
ISIRI 696-1982	"Specification for Quality of Vitreous China Sanitary Appliances"
ISIRI 748-1982	"Building Wooden Doors"
ISIRI 1161-1975	"Ceiling Covers (Made of Plaster)"
ISIRI 1176-1978	"Specification for Finishing Paint, Aluminum Type"
ISIRI 1470-1978	"Method of Test for Plastic Flooring and Wall Tiles"
ISIRI 1471-1976	"Specification for Flexible PVC Flooring"
ISIRI 1472-1976	"Specification for PVC (Vinyl) Asbestos Floor Tile"
ISIRI 1473-1977	"Specification for Polystyrene Wall Tiles"

ISIRI 1600-1977	"Structural Steel"
ISIRI 1651-1977	"Specification for Thermoplastic Flooring Tiles"
ISIRI 1700-1977	"Specification for Decorative High Gloss Paint for Interior and Exterior Use"
ISIRI 1791-1977	"Steel Sections, Hot Rolled I-Beams, Medium Flange"
ISIRI 1792-1977	"Dimensions of Hot Rolled Steel Round Bars"
ISIRI 2225-1993	"Specification for Flat Decorative Alkyd Paint"
ISIRI 2384-1984	"Specification for Extruded Aluminum"
ISIRI 2952-1989	"Asphalt and Hessian for Use in Built-Up Roof Covering"
ISIRI 3050-1990	"Specification for Acid-Resistant Tile"
ISIRI 3132-1991	"Tolerances of Dimension for Round Bars"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 657-1981 to 1989	"Hot Rolled Steel Sections"
ISO 1035-1980	"Hot Rolled Steel Bars"
ISO 4019	"Cold-Finished Steel Structural Sections"

JIS (JAPANESE INDUSTRIAL STANDARD)

R 1501-1991	"General Rules of Acid Proof Porcelains for Chemical Industry"

13. CERAMIC TILES

13.1 General

13.1.1 Ceramic tile is a ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay and other ceramic materials, called the body of the tile, having either a "glazed" or "unglazed" face and fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics.

13.1.2 The glaze is required to be impervious to liquids and should not stain, crack, or craze.

13.1.3 Ceramic tiles are applied on a solid backing by means of a mortar or adhesive. They are usually applied with the thinnest possible mortar joint; consequently accuracy of dimensions is of greatest importance.

13.1.4 Tiles shall be stored in their original packaging in a clean, dry area. Stack cartons on a firm, level base. On solid floors stack on a sheet of polyethylene, pallets or timber to prevent any rising damp affecting the tiles and cartons, as damp cartons can stain tiles.

13.1.5 In this clause of the Standard, characteristics of following types of ceramic tiles are described:

a) Wall tiles (13.2).
b) Floor tiles (13.3).
c) Acid-resistant tiles (13.4).

13.2 Wall Tiles

13.2.1 This clause of the Standard specifies glazed ceramic tiles used for covering interior walls of specific buildings like bathrooms, toilets, kitchens and similar locations in accordance with ISIRI 25. Wall tiles are molded and fired at temperatures exceeding 1000°C.

13.2.2 Dimensions and tolerances

Dimensions and tolerances of wall tiles tested in accordance with ISIRI 25 are shown in Table 34.

Tolerances of length and width of tiles shall be maximum +0.6 percent and minimum -0.3 percent of each side.

13.2.3 Properties

Physical and chemical properties of wall tiles tested in accordance with ISIRI 25 are shown in Table 35.

TABLE 34 - SIZES AND TOLERANCES OF-WALL TILES

NOMINAL SIZE mm	THICKNESS mm	TOLERANCES OF THICKNESS mm
75 × 150	4 and 5	±0.5
100 × 100	5	±0.5
150 × 150	6	±0.5
100 × 200	7	±0.8
150 × 200	7	±0.8
200 × 200	9	±0.8
150 × 300	11	±0.8

TABLE 35 - GENERAL REQUIREMENTS OF WALL TILES

	PROPERTIES	UNIT	REQUIREMENT
1	Flatness of glazed surface (Maximum permissible deviation)	mm	±0.5
2	Edge curvature (permissible deviation) : Tile size 150 × 150 mm and more : Tile size less than 150 × 150 mm	 mm mm	 ±1.0 ±0.6
3	Water absorption	wt %	Max : 18 Min : 12
4	Heat and humidity resistance	See[1)]	Is required
5	Frost resistance[1)]	wt % loss	1.5
6	Thermal shock resistance	See[1)]	Is required
7	Color fastness	See[2)]	Is required
8	Modulus of rupture (min)	MPa (kg/cm²)	17 175
9	Chemical resistance	See[3)]	Is required
10	Abrasion resistance (Hardness)	Mohs Hardness Scales	5

1) No crack and break shall be observed in sample after test.

2) No ink-stain shall be observed in glazed surface of tile at a distance of 1.5 m, after test.

3) No variation in color and composition shall be observed on glazed surface after test.

13.3 Floor Tiles

13.3.1 This Clause of the Standard specifies glazed and unglazed floor tiles primarily used for floor covering for industrial and/or private buildings in accordance with ISIRI 67.

13.3.2 Sizes

Dimensions of floor tiles shall be in accordance with Table 36.

13.3.3 Properties

Properties of floor tiles shall be in accordance with Table 37.

TABLE 36 - SIZES OF FLOOR TILES

THICKNESS mm	HEIGHT mm	WIDTH mm
8 and 10	100 70	100 70
12 and 15	150 100 150	150 100 75
20 and 25	200 200 150	200 100 150

TABLE 37 - GENERAL REQUIREMENTS OF FLOOR TILES

No.	PROPERTIES	UNIT	REQUIREMENT
1	Permissible deviations of width and length	%	±1.0
2	Permissible deviations of thickness	%	±5
3	Permissible deviations of surface flatness (for each 25 mm of side)	mm	0.4
4	Permissible deviation of edge curvature (for each 200 mm of side) [1)]	mm	1.0
5	Water absorption	wt %	0 - 2
6	Heat and humidity resistance [2)]	—	Is required
7	Frost resistance [2)]	—	Is required
8	Thermal shock resistance [2)]	—	Is required
9	Color fastness [3)]		Is required
10	Modulus of rupture (min)	(kg/cm^2)	35
11	Chemical resistance [4)]		Is required
12	Abrasion resistance (min)	g/cm^3	25

1) The angles of edge shall be 90° with tolerance of 1 mm for each 200 mm of side.

2) This test shall be applied in accordance with ISIRI 25 and no cracks shall be observed in sample after test.

3) No ink-stain shall be observed in top surface of tile at a distance of 2 m after test.

4) No variation in color and composition of tile shall be observed after test.

13.4 Acid-Resistant Tiles

13.4.1 Acid-resistant or acid-proof tiles are chemical stoneware bodies with or without glaze, and shall have high strength and good resistance to acids (except Hydrofluoric acid and its compound) and area used for covering floors and walls of laboratories and similar locations where resistant against acids are important.

The alkali resistance of these tiles is not required. Acid-resistant tiles shall be used with acid-resistant cement or adhesive for applying on surfaces. This subclause specifies the requirements for acid-resistant tiles in accordance with ISIRI 3051 and JIS R 1501.

13.4.2 Chemical composition

The chemical composition of stoneware body shall be as follows:

Silicic acid %	65 - 85
Aluminum oxide %	10 - 25
Ferric oxide %	0.5 - 5
Alkali and others %	2 - 10

13.4.3 Dimensions

The thickness of tiles shall not be more than 25 mm. The tolerances on dimensions shall not be more than 2.5 percent.

13.4.4 Properties

Acid-resistant tiles shall have regular shape and be free from flaws and cuts harmful to use.

The quality of acid resistance tiles shall be as specified in Table 38.

TABLE 38 - PROPERTIES OF ACID-RESISTANT TILES

PROPERTIES	UNIT	REQUIREMENT
Water absorption (max)	wt %	3
Compressive strength (min)	MPa	70
Modulus of rupture (min)	MPa	20
Resistance to abrasion-average	mm	2
Rectangularity, Permissible deviations related to side length	%	1
Resistance to acids-max weight loss (except for hydrofluoric acid and its compounds)	wt %	2
Permissible deviations width, length and thickness (max)	%	±2.5

14. VITREOUS CHINA SANITARY APPLIANCES

14.1 General

Vitreous china sanitary appliances consist of high-grade ceramic ware made from a mixture of white burning clays and finely-ground minerals which, after firing at a high temperature and when unglazed, does not have a mean value of water absorption greater than 0.5% of the dry weight. It is coated on all exposed surfaces with an impervious non-crazing vitreous glaze giving a white or colored finish.

This section of the Standard specifies the requirements of vitreous china sanitary appliances in accordance with ISIRI 696 (BS 3402).

14.2 Quality of Glazing

The glaze shall be thoroughly fused to the body. Subject to the exceptions given in 14.1, 14.2 and 14.3 all exposed surfaces shall be glazed.

14.2.1 Surfaces coming into contact with walls and floors may be without glaze.

14.2.2 On wash basins set away from walls, those portions of the rear aprons used for supporting the appliances in kilns; the backs of overflows and the undersides of outlet bosses may be without glaze.

14.2.3 Appliances other than wash basins may have unglazed portions where supported in the kilns, but the unglazed surfaces shall not be visible when the appliance is installed in the normal manner.

14.3 Properties

The properties of vitreous china sanitary appliances shall be in accordance with Table 39.

TABLE 39 - PROPERTIES OF VITREOUS CHINA APPLIANCES

No.	PROPERTIES	UNIT	REQUIREMENT
1	Tolerances - on dimensions not less than 75 mm - on dimensions less than 75 mm - on the height of the flush outlet of p-traps	 % % mm	 ±2 ±5 ±4
2	Water absorption (max) - individual value - arithmetical mean value	 wt % wt %	 0.75 0.50
3	Crazing	—	Is required (see Note 1)
4	Chemical resistance	—	Is required (see Note 2)
5	Resistance to staining and burning	—	Is required (see Note 3)
6	Modulus of rupture (average)	MPa (kgf/mm²)	35 (3.5 to 4.5)

Notes:

1) When tested, none of the test pieces shall show crazing.

2) When tested, none of the test pieces shall appear to the unaided eye of a trained observer to have suffered any loss of reflectivity on the glaze when compared with the control sample.

3) When tested, no stain shall remain on either of the test pieces.

15. WATERPROOFING MATERIALS (ASPHALT AND HESSIAN CLOTH)

15.1 General

15.1.1 Waterproofing (dampproofing) in the building is the treatment of roof, wall, floor, or foundations to prevent the passage of damp and water under hydrostatic pressure.

15.1.2 Asphalt and hessian cloth are the materials used for dampproofing and waterproofing of building. Asphalts for various purposes used in building is divided into following groups:

a) Asphalt used in roofing, (15.2).
b) Asphalt used in dampproofing and waterproofing (15.3).
c) Asphaltic primer (15.4).

Specification of hessian cloth is described in 15.5.

Specification of roofing bitumen felt is described in 15.6.

15.1.3 For general information about insulation with bituminous materials see ISIRI 211 and BS 8000 (4).

15.1.4 Storage of materials

- Store asphalt and bitumen blocks separately on a clean base and in order of their various grades.

- Store rolls of hessian cloth under covered areas; supporting them in a suitable method in order to avoid distortion and to protect them against wetting, mechanical damage and contamination.

- Do not apply or lay materials on substrates which are frozen or have been affected by frost.

15.2 Asphalt Bitumen Used in Roofing

15.2.1 This clause is intended for general classification purposes only, and does not imply restrictions on the roof slope at which an asphalt must be used.

15.2.2 Asphalts shall be homogeneous and free of water and shall conform to the physical properties prescribed in Table 40.

15.2.3 Sampling and test methods of asphalts for roofing shall be in accordance with ISIRI 2952 and ASTM D 312.

TABLE 40 - PHYSICAL PROPERTIES OF ASPHALT USED IN ROOFING

No.	PROPERTY	UNIT	TYPES OF ASPHALT			
			60/70	85/25	90/15	100/10
1	Softening point*	°C	49 to 56	80 to 90	85 to 95	95 to 100
2	Penetration*, units: - at 0°C - at 25°C - at 46°C	mm	 5 60-70 90-180	 6 20-30 20-40	 6 10-20 15-35	 6 5-15 10-25
3	Ductility at 25°C (min.)	mm	100	30	25	15
4	Flash point (min)*	°C	250	225	225	225
5	Solubility in trichloro ethylene (min)	wt %	99.5	99	99	99
6	Specific gravity (at 25/25°C)	—	1.01-1.06	1.05	1.05	1.05
7	Loss on heating (max)	wt %	1	1	1	1

*** Classification in accordance with NIOC products.**

15.3 Asphalt Used in Dampproofing and Waterproofing

15.3.1 This clause of the Standard covers three types of asphalt suitable for use as a mopping coat in dampproofing; or as a plying or mopping cement in the construction of membrane waterproofing systems with felts, in accordance with ISIRI 2952.

15.3.2 Asphalts covered by this clause include three types:

Type I: A soft, adhesive, "self-healing" asphalt that flows easily under the mop and is suitable for use below grade under uniformly moderate temperature conditions both during the process of installation and during service.

Type I asphalt is suitable for foundation, tunnel subways, etc.

Type II: A somewhat less susceptible asphalt than Type I with good adhesive and "self-healing", properties, suitable for use above grade where it will not be exposed to temperatures exceeding 50°C.

Type II asphalt is suitable for railroad bridges, culverts, retaining walls, tanks, dams, conduits, spray decks, etc.

Type III: An asphalt less susceptible to temperature than type II, with good adhesive properties, and suitable for use above grade on vertical surfaces exposed to direct sunlight or temperatures above 50°C.

15.3.3 Sampling and testing of asphalt used in dampproofing and waterproofing shall be in accordance with ISIRI 2952 and ASTM D 449-79 (83).

15.3.4 The physical properties of asphalt shall be in accordance with Table 41.

TABLE 41 - PHYSICAL PROPERTIES OF ASPHALT USED IN DAMPPROOFING AND WATERPROOFING

No.	PROPERTY	UNIT	TYPES		
			Type 1	Type 2	Type 3
1	Softening point*	°C	46 to 60	63 to 77	82 to 93
2	Penetration, units: - at 0°C - at 25°C - at 46°C		 5 50-100 Min 100	 10 25-50 Max 130	 10 20-40 Max 100
3	Flash point (min)	°C	175	200	205
4	Ductility at 25°C (min)	mm	300	100	20
5	Solubility in trichloro ethylene (min)	wt %	99	99	99

15.4 Asphaltic Primer

15.4.1 This clause of the Standard covers asphaltic primer suitable for use with asphalt in dampproofing and water-proofing below or above ground level for application to concrete and masonry surfaces.

15.4.2 Sampling and testing of asphalt primer shall be in accordance with ISIRI 2952 and ASTM D 41-85.

15.4.3 The primer shall conform to items 1, 2, 3 of Table 42.

15.4.4 The residue obtained from the distillation up to 360°C shall conform to items 4 and 5 of Table 42.

15.5 Hessian Cloth (Burlap Fabrics)

15.5.1 Woven hessian cloth used for waterproofing and dampproofing of buildings shall be composed of 100% jute fiber.

15.5.2 Sampling and test method of hessian cloth shall be in accordance with ISIRI 2952 and ASTM D 1327-86.

15.5.3 The physical properties of hessian cloth shall be in accordance with Table 43.

TABLE 42 - PHYSICAL PROPERTIES OF ASPHALT PRIMER

No.	PROPERTIES	UNIT	REQUIREMENT
1	Viscosity at 25°C (saybolt furol)	Second	25 to 75
2	Distillation - up to 225°C - up to 360°C	 wt % wt %	 35 (min.) 65 (max.)
3	Water content	wt %	Zero
4	Penetration of residue obtained from distillation (at 25°)	—	20 to 50
5	Solubility in trichloro-ethylene	wt %	99 (min.)

TABLE 43 - PHYSICAL PROPERTIES OF HESSIAN CLOTH FOR WATERPROOFING

No.	PROPERTIES	UNIT	REQUIREMENT
1	Average net mass per unit area	g/m²	310
2	Thread count per one decimeter - Warp - Fill	 — —	 43 ±3 43 ±3
3	Average breaking strength at 21°C - Lengthwise (warp direction) - Crosswise (fill direction)	 N* N*	 686 784
4	Mesh size in direction of warp and fill	mm	min. 2.2 max. 2.5

*** Newton**

15.6 Roofing Bitumen Felt

15.6.1 Description

A roofing bitumen felt consists essentially of a sheet of matted fiber rendered partially or completely impervious to water by treatment with bituminous materials. This subclause specifies roofing bitumen felt in accordance with BS 747-1977.

15.6.2 Composition

Roofing bitumen felt shall be produced of following layers:

a) Layer of base fiber

According to the purpose the layer of base fiber consists of following types:

- Vegetable fiber (e.g. cotton, jute, flax);
- sheet of asbestos fiber;
- glass fiber;
- polyester fiber.

b) Layer of bitumen

(See Section 15 of this Standard).

c) Layer of mineral surfacing material

(e.g. natural sand, mineral granules or other suitable aggregates) (see Section 5 of this Standard).

15.6.3 Types of felt and properties

The type of felts, and their properties shall be in accordance with Table 44.

15.6.4 Material used for application

For application of roofing bitumen felt the following material shall be used:

a) Bitumen primer (see 15.4) is applied prior to roofing felt.
b) Bitumen adhesive dressing compound (BS 3690) is applied over roofing felt for bedding mineral chipping.

For information about application of roofing felt see BS CP 144 Part 3.

TABLE 44 - PROPERTIES OF ROOFING BITUMEN FELT

TYPE OF ROOFING FELT	STANDARD SPECIFICATION	TYPE OF BASE FIBER	MASS (min) g/m²	BREAKING LOAD (min) kN/m	PLIABILITY
Asphalt-saturated cotton felt	ASTM D 173-86	Woven cotton fabric	340	Warp direction 8.76 Fill direction 8.76	No cracking
Asphalt-saturated organic felt	ASTM D 226-89	Polyester fiber	560	With fiber grain 5.25 Across fiber grain 2.63	No cracking
Asphalt-saturated asbestos felt	ASTM D 250-88	Asbestos fiber	830	With fiber grain 4.7 Across fiber grain 2.3	No cracking
Asphalt-saturated glass felt	ASTM D 3909-86	Fine glass fiber	3085	Not specified	No cracking

16. PLASTICS FLOOR COVERINGS

16.1 Description

This clause of the Standard covers Poly-Vinyl Chloride (PVC) floor coverings (non-asbestos formulated) in shape of square tiles, sheets and roll, with both smooth and embossed surfaces in accordance with ISIRI 1471, 1472 and 1651.

16.2 Types of Pattern:

a) Solid color tile

Shall be uniform throughout.

b) Through pattern tile

The patterning shall be distributed throughout the thickness of tile.

c) Surface pattern tile

The pattern of this tile need not extend through the entire thickness of tile.

These types of PVC floor tiles may have either smooth or embossed wearing surfaces.

16.3 Material

The tile shall consist of binder fillers and pigments. The binder shall contain of one or more resins of poly (vinyl chloride) or vinyl chloride copolymers, or both, compounded with suitable plasticizers and stabilizers. Other suitable polymeric resins may be incorporated as a part of the binder.

Color, pattern, and wearing surface as applicable shall be specified in the contract or order.

16.4 Dimensions

16.4.1 Thickness

The thickness of PVC floor covering with or without backing shall be in accordance with Table 45 with tolerances of ±0.15 mm.

16.4.2 Width

Width of square tile and tolerances shall be in accordance with Table 46. Width of sheet and roll of PVC floor covering shall be 1.5, 2, and 10 meters respectively with tolerances of ±0.1 percent.

16.5 Physical Properties

16.5.1 Indentation

When the PVC floor cover is tested in accordance with ISIRI 1470. The indentation at the end of 1 min. shall not be more than 0.7 mm and indentation at the end of 10 min. shall not be more than 0.89 mm (see ISIRI 1471, Table 2).

16.5.2 Flexibility

When tested in accordance with ISIRI 1470 the covering shall not break or crack.

16.5.3 Resistance to chemicals

The chemical resistance of covering shall be determined when exposed to the following chemicals: 95% ethanol, tallow, mineral oil, vegetable oil, kerosene, and 5% solution of sodium hydroxide. After immersion the color of sample shall not be change in comparison with original color.

TABLE 45 - THICKNESS

THICKNESS mm	
Floor covering with backing	Floor covering without backing
2.0	1.5
2.5	2.0
3.0	2.5
4.0	3.0
5.0	4.0

TABLE 46 - TOLERANCES

DIMENSIONS	TOLERANCES
Thickness	±0.15 mm
Width of square tile	
300 mm	±0.2 mm
600 mm	±0.4 mm
900 mm	±0.6 mm
Width of sheet and roll	±0.1 percent

17. GRATINGS

17.1 General

Gratings consist of following types:

a) Hot rolled patterned plate (17.2).
b) Open bar grating (17.3).
c) Expanded metal grating panels (17.4).

For specifications of other floor coverings, including terrazzo tiles, see 9.5, building stones see section 6 and floor ceramic tile see 13.3.

17.2 Hot Rolled Patterned Plate

17.2.1 Description

This clause of the Standard specifies the hot rolled patterned plate (bulb plate, checker plate), 3 mm to 10 mm thick in width from 600 up to 2000 mm made from steel (see ISIRI 1600).

This specification only applies to materials having a specified minimum yield strength up to 355 N/mm² in accordance with Din 59200.

17.2.2 Types of pattern (see Fig. 1):

- Pattern T or bulb plate.
- Pattern R or checker plate.

Notes:

1) The values given in the illustrations are guideline values.
2) The patterns shall not be in parallel to the longitudinal edge of the plate.

17.2.3 Dimensions

17.2.3.1 Thickness

The nominal thicknesses of the plates are from 3 to 10 mm.

17.2.3.2 Width

Patterned steel plate is usually supplied in widths from 600 mm up to 2000 mm. It is permitted to exceed the nominal width ordered by 20 mm. A negative deviation in nominal width is not permitted.

17.2.3.3 Length

The nominal length of plates are from 4000 to 20000 mm with a permissible positive deviation in nominal length of 20 up to 100 mm respectively. A negative deviation is not permitted.

17.2.3.4 Height of pattern shall be 1 to 2 mm (see Fig. 1c).

17.2.4 Mass

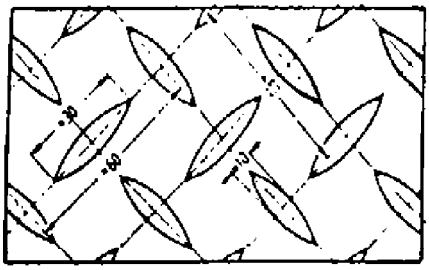
The theoretical mass and tolerances are given in Table 47 (density is 7.85 kg/dm³).

It has been established by taking the theoretical mass of the base metal with an addition for the embossed pattern:

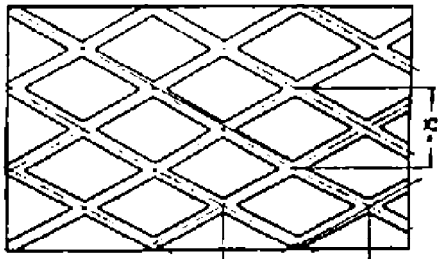
2 kg/m² for pattern T, and
4 kg/m² for pattern R.

TABLE 47 - THEORETICAL MASS AND PERMISSIBLE DEVIATIONS IN MASS

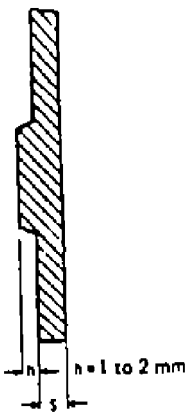
NOMINAL THICKNESS (S)	THEORETICAL MASS kg/m²		PERMISSIBLE POSITIVE DEVIATION FROM THE THEORETICAL MASS, IN %, FOR QUANTITIES DELIVERED, IN TONS				
	For pattern						
	T	R	Below 5	From 5 up to but not including 15	From 15 up to but not including 40	From 40 up to 250	Over 250
3	25.55	27.55	13.5	13	12	11.5	11
4	33.40	35.40	13.5	13	12	11.5	11
5	41.25	43.25	13.5	13	12	11.5	11
6	49.10	51.10	13.5	13	12	11.5	11
8	64.80	66.80	11.5	11	10	9.5	9
10	80.50	82.50	11.5	11	10	9.5	0



a) Pattern T



b) Pattern R



c) Height of pattern

PATTERN PLATE
Fig. 1

17.3 Open Bar Grating

17.3.1 Description

This Clause specifies requirements for steel open bar gratings intended for use in floorings, walkways and stair treads, in accordance with BS 4592 Pt. 1-1987. Definitions of some common terms are illustrated in Fig. 2.

17.3.2 Types of bars (refer to Fig. 2)

A) Loadbearing bar

Longitudinal load bearing member spanning between supports.

B) Transverse bar

Member fixed at right angles to load bearing bars to provide lateral restraint.

C) Pressed bar

Member fixed diagonally between adjacent loadbearing bars to provide lateral restraint.

D) Binding bar

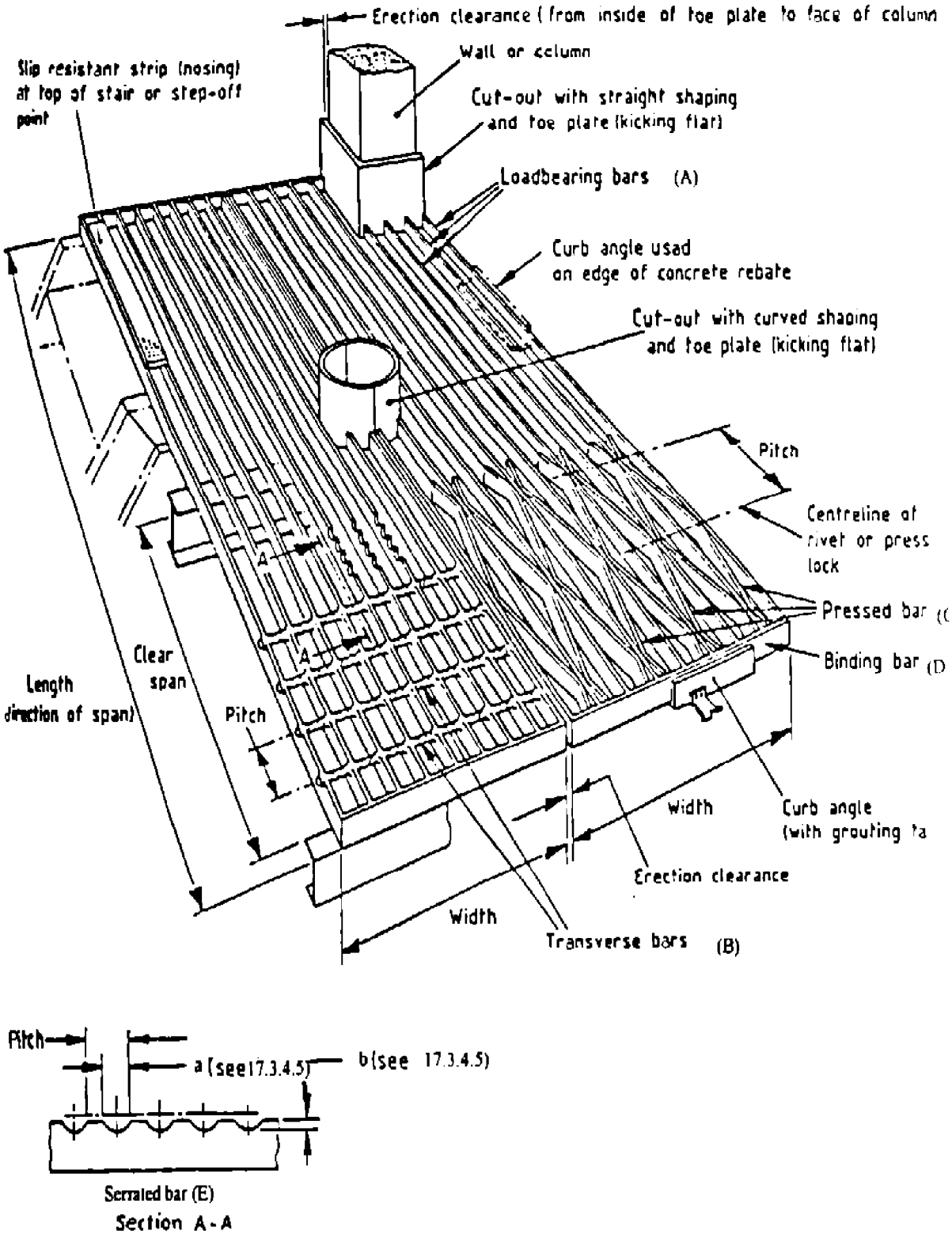
Bar or section fixed to the edge at a grating, flush with the top of the load bearing bar.

E) Serrated bar

Bar with serrated top surface.

17.3.3 Materials

17.3.3.1 Open bar gratings shall be made of low carbon steel complying with BS 4360, grade 43 A.



GRATING TERMS
Fig. 2

17.3.3.2 Protection against corrosion

Grating shall be free draining. The requirements for protection against corrosion will vary according to the end use and should be agreed between manufacturer and Company. For external protection, hot dip galvanizing is recommended.

17.3.4 Sizes

17.3.4.1 The minimum thickness of members shall be 3 mm, subject to the tolerances given in the appropriate material standard. The thickness of binding bars (see 17.3.2 D) that are loadbearing shall be not less than the thickness of the loadbearing bars (see 17.3.2.A).

Note:

In corrosive atmospheric conditions (see Table 1 of BS 5493: 1977) the thickness of loadbearing bars should be not less than 5 mm.

17.3.4.2 The cross-sectional area shall be not less than 28 mm² for transverse bars (see 17.3.2 B) or 45 mm² for pressed bars (see 17.3.2 C).

17.3.4.3 The clear distance between loadbearing bars shall not exceed 40 mm.

17.3.4.4 The pitch of transverse bars shall not exceed 115 mm and the pitch of pressed bars shall not exceed 210 mm.

17.3.4.5 For serrations (see Fig. 2) dimension "a" shall be not less than 55% of their pitch and dimension "b" shall be not less than 1.5 mm. There shall be not less than five serrations per 100 mm length of grating.

17.3.5 Joints

17.3.5.1 Loadbearing bars shall be provided with lateral restraint by means of transverse bars (see 17.3.2 B) or pressed bars (see 17.3.2 C), fixed at each point of intersection or contact with the loadbearing bars by means of welding (see 17.4.5.2).

17.3.5.2 Welding of steel shall either be arc welding in accordance with BS 5135 or resistance welding.

17.3.5.3 Where the function of binding bars excludes load transfer, they shall be secured to at least every fifth load-bearing bar. Where the binding bars are loadbearing, they shall be secured to every loadbearing bar. If welded, the weld fillet shall be equivalent to the thickness of the loadbearing bar, throughout the depth and on one side of the loadbearing bar.

17.3.5.4 Longitudinal ties between supports shall be below the underside of loadbearing bars.

When binding bars are applied along the length of a grating, they shall be secured at every transverse bar or at every point where they are in contact with a pressed bar.

17.3.5.5 Where a cut-out (see Note) is required in a grating, the opening shall be trimmed with a binding bar or, where specified, a toe plate.

Note:

Cut-out is the area where grating has been removed to permit services plant or structural members to pass through or to clear obstructions.

17.3.5.6 Open bar gratings shall withstand the appropriate loads given in Table 48. Where a cut-out is required, the remaining area of the grating shall be able to carry the same load.

The positions of concentrated loads shall either be those which produce the maximum stresses, or where deflection is the design criterion, those which produce maximum deflection.

TABLE 48 - LOADS (see Note 1)

USE OF GRATING	UDL (SEE NOTE 2)	CONCENTRATED LOAD OVER SQUARE OF 300 mm SIDE
	kN/m²	kN at 1.0 m centers
Light duty. Access limited to one person	3.0	1.0
General duty. Regular two-way pedestrian traffic	5.0	1.0
Heavy duty. High density pedestrian traffic	7.5	1.0 (See Note 3)

Notes:

1) Loads are to be taken to be safe working loads for permissible stress design or characteristic loads for limit state design.
2) The Uniformly Distributed Load (UDL) is the equivalent uniformly distributed static load per square meter of plan area.
3) Greater concentrated loads may be required where machinery or other items are to be placed on the flooring.

17.4 Expanded Metal Grating Panels

17.4.1 Description

This clause of the Standard specifies requirements for expanded metal grating panels intended for use in flooring, walk-ways and stair treads in accordance with BS 4592, Part 2. Grating panels are formed by slitting and expanding blank metal plates in a single continuous process.

17.4.2 Types of grating panel:

a) Regular knuckle grating panel

Grating panel with regular knuckle between strands (see Fig. 3 a).

b) Long knuckle grating panel

Grating panel with long knuckle between strands (see Fig. 3 b).

c) Dimpled long knuckle grating panel

Grating panel with knuckle that has a dimple pressed into the surface to increase slip resistance (see Fig. 3 c).

17.4.3 Material

Expanded metal grating panels shall be made by low carbon steel complying with BS 1449, Part 1.

17.4.4 Protection against corrosion

Galvanizing shall be carried out for low carbon steel as specified in BS 729.

17.4.5 Sizes (see Fig. 4)

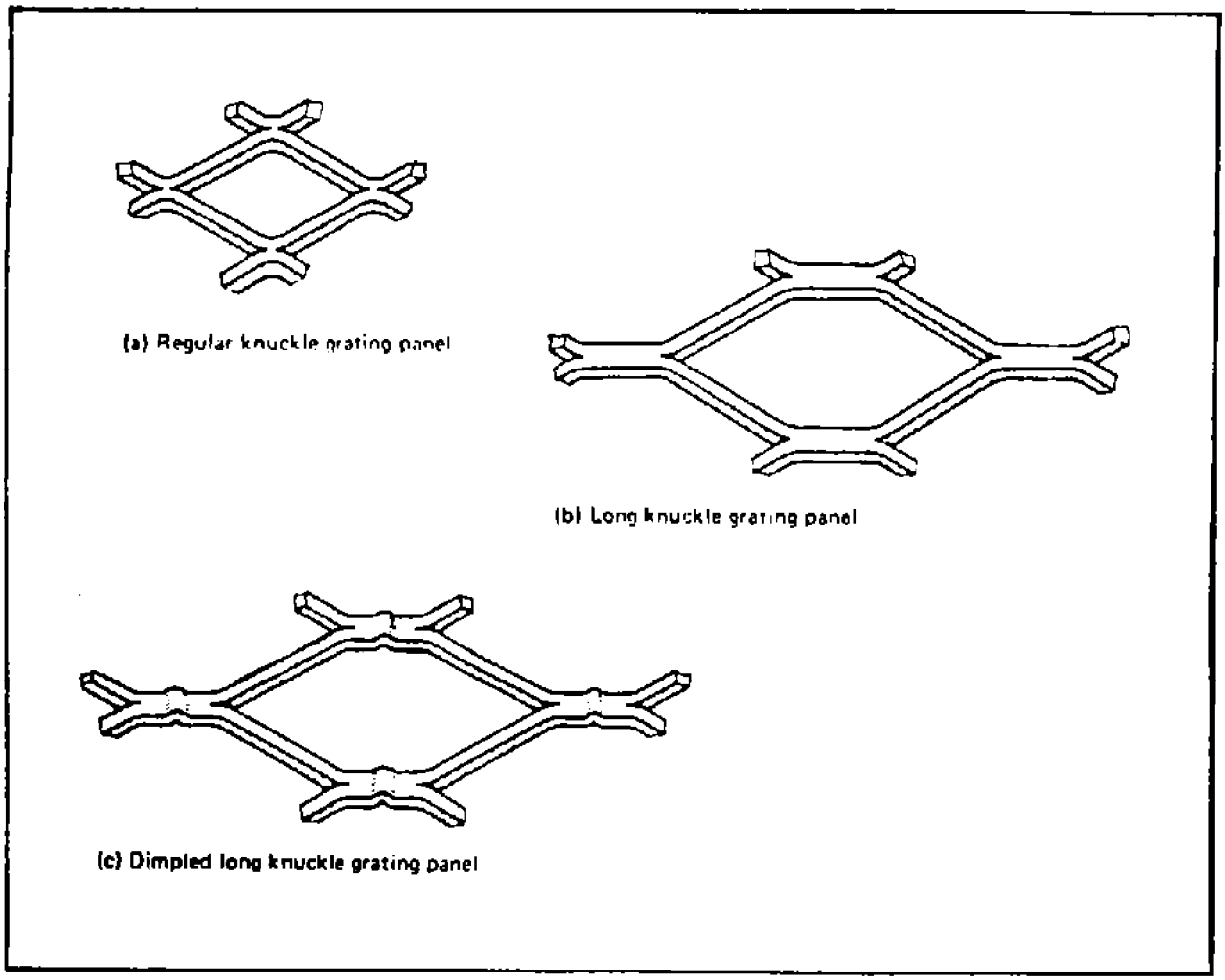
1) Framed grating panels

Grating panels are framed with angles, tee bars, flat bars or similar. For framed grating panels the long way and the short way may be cut to complete meshes or be random cut.

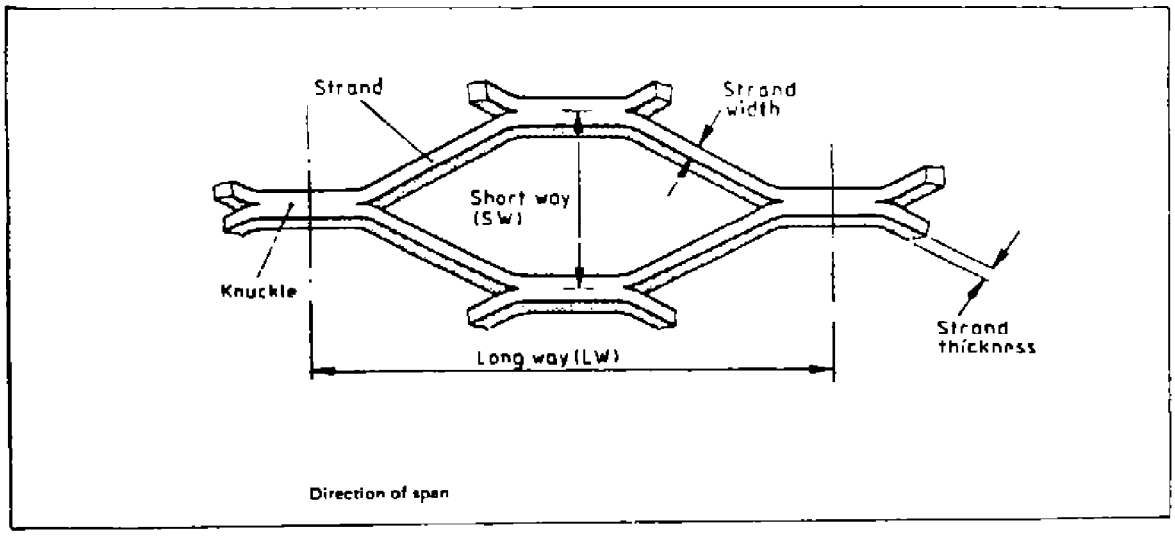
2) Unframed grating panels

For unframed grating panels, work size shall be half or whole multiples of the long way. The short way shall be cut to a complete mesh.

3) Treads shall consist of framed grating, panels and shall be not less than 25 mm in thickness.



TYPES OF GRATING PANEL
Fig. 3



GRATING PANEL TERMS
Fig. 4

17.4.6 Physical properties

Expanded metal grating panels shall withstand the appropriate loads given in Table 48.

The positions of concentrated loads shall either be those which produce the maximum stresses or where deflection is the design criterion, those which produce maximum deflection.

18. SOUND ABSORPTION TILES (ACOUSTICAL TILES)

18.1 General

18.1.1 Sound absorption or acoustical materials are any material considered in terms of its acoustical properties. Commonly and especially a material designed to absorb sound and to reduce the sound energy.

18.1.2 This Section of the Standard specifies the requirements of following types of sound absorption materials used for covering wall and ceiling:

a) Polystyrene tiles (18.2).
b) Gypsum plaster board (18.3).

18.1.3 Types of tile pattern

18.1.3.1 The acoustical tiles have been divided into four types:

Type A) Resonant panels.
Type B) Porous surface panels.
Type C) Semi-perforated and perforated composite panels.
Type D) Perforated panels backed with independent acoustic absorbent materials.

18.1.3.2 Type (A) panels are efficient at the lower frequencies and include a wide variety of unperforated materials ranging from relatively dense material such as plywood, hardboard etc. to light materials such as expanded polystyrene.

18.1.3.3 Type (B) panels absorb mainly at higher frequencies than Type (A) and include those fabricated from minerals, wood or vegetable fiber and felts. Same types are also faced with thin cloth or this plastic membrane.

18.1.3.4 Type (C) and (D) panels have been designed to absorb sound over a wide frequency range as they tend to combine the attributes of Types A and B.

18.1.3.5 Type (C) panels - The surfaces of porous panels may be textured, fissured, perforated, drilled or slotted to increase their acoustic efficiency and improve their appearance.

18.1.3.6 Type (D) panels are perforated panels over an airspace containing a porous absorbent type combining the advantages of porous surface panels (Type B) with resonant panels (Type A).

18.2 Polystyrene tiles

18.2.1 Description

This Clause specifies the requirements for polystyrene tiles that provide acoustical performance and include interior ceiling and wall coverings in buildings, in accordance with ISIRI 1473.

18.2.2 Composition

The composition of polystyrene tiles shall be polystyrene resin, fillers, and pigments.

18.2.3 Size of tiles

Dimensions, thickness and weight of tiles shall be in accordance with Table 49 and Fig. 5.

18.2.4 Sound absorption coefficients (S.A.C) : (test method ASTM C 423)

Sound absorption coefficient of a surface means the measure of the sound absorptive property of a material in a specified frequency (metric unit: sabin/m²).

The sound absorption coefficients of polystyrene tile shall be in accordance with Table 50.

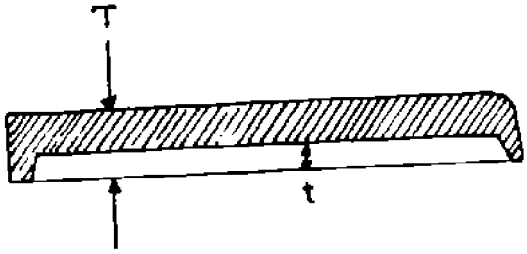
18.2.5 Properties

18.2.5.1 Physical properties and method of testing shall be in accordance with ISIRI 1473.

18.2.5.2 Water absorption of tiles shall not be more than 5 wt%.

TABLE 49 - SIZE OF TILES

DIMENSION (mm)	TOLERANCES IN DIMENSION (mm)	THICKNESS (T) min. (mm)	THICKNESS (t) min. (mm)	WEIGHT (kg/m²)
99 × 99	±1	1.25	0.62 ±0.12	1.05
148.5 × 148.5	±1.5	1.75 2.00	0.62 ±0.12	1.35



THICKNESSES OF TILES
Fig. 5

TABLE 50 - SOUND ABSORPTION COEFFICIENTS S.A.C OF POLYSTYRENE TILES

FREQUENCY	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
S.A.C (Sabin/m²)	0.05	0.15	0.40	0.35	0.2	0.2

18.3 Gypsum Plaster Board (Ceiling Board)

18.3.1 Description

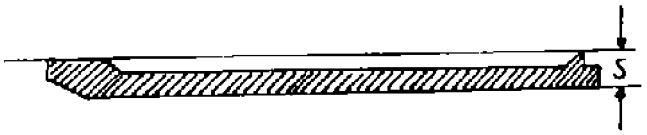
This clause of the Standard specifies the requirements for gypsum plaster boards with or without mineral fiber backing in order to provide lining and acoustical performance for interior walls and ceiling in a building in accordance with ISIRI 1161. Gypsum plaster boards have the same face pattern mentioned in Subclause 18.1.3.

18.3.2 Composition

The composition of face of tiles shall consist of gypsum and additives, and back side of tiles should be of glass fiber or mineral wool.

18.3.3 Size of tiles

Dimension	:	625 × 625 mm
Tolerances	:	±1 mm
Thickness (s)	:	Minimum 28 mm (see Fig. 6)
Permissible wrap	:	Maximum 1 mm
Weight per square meter	:	Minimum 15 kg, Maximum 20 kg



THICKNESS OF TILES
Fig. 6

18.3.4 Sound absorption coefficients (see 18.2.4)

The Sound Absorption Coefficients (S.A.C) of acoustical gypsum tiles (with backing), shall meet the requirements prescribed in Table 51.

TABLE 51 - SOUND ABSORPTION COEFFICIENTS (S.A.C) OF GYPSUM TILES

FREQUENCY	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
S.A.C (Sabin/m²)	0.45	0.70	0.8	0.8	0.65	0.45

19. PAINTS

19.1 General

19.1.1 This Section covers specification of paints used for initial and maintenance painting of buildings in which decoration is a significant and often the major factor. Another function of building paint is to protect many building materials against weathering or other forms of attack normally encountered in various types of buildings referred to.

19.1.2 For selection of suitable types of paints see IPS-E-TP-100 and for painting specifications see IPS-C-TP-102.

19.1.3 Sampling and testing of paints shall be in accordance with ISIRI 526.

19.1.4 Prior to painting of building surfaces, initial preparation of them is a necessity. The preparation of metallic and non-metallic surfaces shall be in accordance with IPS-C-TP-101.

19.1.5 Storage of paint

19.1.5.1 Paint shall be stored in a well ventilated room, free from excessive heat or direct rays of the sun and maintained at a temperature of between 4°C and 27°C. Open air storage shall be avoided particularly for heavy paints, such as primers.

19.1.5.2 Paints shall not be stored in open containers, even for a short time.

19.1.5.3 The settlement of heavy paints such as red lead oxide primer and wood priming paints shall be minimized by rolling the drums in which they are stored every six weeks. Turing the drums on their ends is not allowed. The normal finishing paints and drum paints do not require rolling during the storage period.

19.1.5.4 Paint which has livered, gelled, or otherwise deteriorated during storage shall not be used.

19.1.5.5 The oldest paint of each kind shall be used first.

19.1.5.6 Temperature of paint may be excessively high or low depending on storage or shipping conditions. If so, warm or cool the paint to a temperature of 10 - 32°C before mixing and use.

19.1.6 Types of paint

This sub-clause of the Standard specifies the requirements of following types of building paint used for protecting metallic and nonmetallic surfaces:

a) Decorative gloss oil-base paint (19.2).
b) Decorative matt oil-base paint (19.3).
c) Decorative emulsion paint (19.4).

d) Aluminum paint (19.5).
e) Swimming pool paint (19.6).
f) Traffic paint (19.7).
g) Paints for steel structures (19.8).

19.2 Decorative Gloss Oil-base Paint

19.2.1 Description

This sub-clause covers the specification of decorative gloss oil paint based on alkyd resin for application by brushing, roller coating, spraying in accordance with ISIRI 1700. Gloss alkyd paint is used for interior and exterior finishing of wood, plaster, metal, masonry and previously painted surfaces.

19.2.2 Analysis of paint

Chemical analysis determines whether the specified components are present and if they are, in what amounts. The analysis of alkyd gloss paint shall be in accordance with Table 52.

19.2.3 Paint properties

The properties of glass oil-base paint shall be in accordance with Table 53.

TABLE 52 - CHEMICAL ANALYSIS OF DECORATIVE GLOSS OIL-BASE PAINT

No.	CONTENT	PERMISSIBLE VALUE (wt %)
1	Acid content of drying oil, based on nonvolatile vehicle, (min.)	60
2	Phthalic anhydride, percent by weight of nonvolatile vehicle, (min.)	20
3	Total volatile content (max.)	40 - 50
4	Water content- (max.)	2
5	Colophon resin and its derivatives and phenolic resin	0

19.2.4 Working properties

Gloss alkyd paint shall be capable of application by brush; spray and roller. The painted surface shall show no streaking, running, or sagging, and shall present a smooth uniform finish after drying.

TABLE 53 - PROPERTIES OF GLOSS OIL-BASE PAINT

No.	PROPERTIES	REQUIREMENT
1	Condition in container	Thickening, settling, and separation are undesirable and objectionable if the paint cannot be reconditioned with a reasonable amount of stirring.
2	Skinning	Sample tested in accordance with ISIRI 1700 shall not contain any skin formation
3	Coarse particles and skins. (max.)	0.5 wt % (Retained on 45 μm sieve)
4	Viscosity (consistency)	80 - 95 KU (krebs unit)
5	Fineness of grind (max.)	20 μm
6	Drying time. (max.): Surface-dry Hard-dry	 4 hr. (max.) 16 hr. (max.)
7	Flexibility	If the sample tests is performed in accordance with ISIRI 1700, no cracking shall be observed on paint surface.
8	Light reflectance	Shall be in accordance with ISIRI 1700
9	Hiding power	Shall be in accordance with ISIRI 1700

19.3 Decorative Matt Oil-Based Paint

19.3.1 Description

This Clause covers the specification of decorative matt oil paint based on alkyd resin for application by brushing and spraying in accordance with ISIRI 2225. Matt alkyd paint is used for interior and exterior finishing of wood, plaster, metal and previously primed surfaces.

19.3.2 Analysis of paint

Chemical analysis of matt alkyd paint shall be in accordance with Table 54.

19.3.3 Paint properties

The property of liquid matt alkyd paint shall be in accordance with Table 55.

19.3.4 Working properties

Matt alkyd paint shall be capable of application by brush and spray. The painted surface shall show no streaking, running, or sagging after drying and shall present a smooth uniform finish.

TABLE 54 - CHEMICAL ANALYSIS OF DECORATIVE MATT OIL-BASE PAINT

No.	CONTENT	PERMISSIBLE VALUE (wt %)
1	Acid content in drying oil, based on nonvolatile vehicle, (min.)	60
2	Phthalic anhydride, percent by weight of nonvolatile vehicle	20 - 25
3	Volatile content (max.): a) Paints with dark shade. b) Paints with light shade	 30 25
4	Dry resin (min.)	20
5	Pigment and extender content (max.): a) Paints with dark shade b) Paints with light shade	 50 45 - 55
6	Additives	2 - 5
7	Water content	0
8	Colophon and its derivatives	0

TABLE 55 - PROPERTIES OF MATT OIL-BASE PAINT

PROPERTIES	REQUIREMENTS
Condition in container	Thickening, settling and separation are undesirable and objectionable if the paint cannot be reconditioned with a reasonable amount of stirring.
Coarse particles and skins (max.)	0.1 wt % (retained on 45 μm sieve)
Viscosity (consistency)	90 - 105 KU (krebs unit)
Fineness of grind (max.)	25 μm
Flexibility	If the sample tests is performed in accordance with ISIRI 528, no cracking shall be observed.

19.4 Decorative Emulsion Paint (Based on PVAc Copolymer)

19.4.1 Description

This subclause covers the specification of decorative emulsion paint based on polyvinyl acetate copolymer emulsion resin, in accordance with ISIRI 289. Emulsion paint is used for finishing interior and exterior of plaster, cement and brick surfaces.

19.4.2 Analysis of paint

The amount of volatile material in emulsion paint shall not be more than 50 percent by weight.

19.4.3 Physical properties

The properties of decorative emulsion paint shall be in accordance with Table 56.

19.4.4 Working properties

Emulsion paint shall be capable of application by brush, spray and roller. The painted surface shall show no streaking, running or sagging, and shall present a smooth uniform finish after drying.

TABLE 56 - PROPERTIES OF DECORATIVE EMULSION PAINT

PROPERTY	REQUIRED
Condition in container	Thickening, settling and separation are undesirable and objectionable if the paint cannot be reconditioned with a reasonable amount of stirring.
Fineness of grind max	50 μm
Viscosity (consistency)	82 - 130 KU (krebs unit)
Drying time	1 hr. (max.)
Flexibility	If the sample tests is performed in accordance with ISIRI 289, no cracking shall be observed on paint surface.
Light reflection and hiding power	Shall be in accordance with ISIRI 289
Specular gloss (60-degree)	10 (max.)
Odor	The paint shall not have an unpleasant or irritating odor in container and during application and drying.

19.5 Aluminum Paint

19.5.1 Description

This Clause covers specification of aluminum paint with leafing pigment that shall be suitable for use for decorative and protective coating of metals and previously primed surfaces in accordance with ISIRI 1176. Aluminum paints have the following types:

Type A : Aluminum paints based on long oil alkyd resin.
Type B : Aluminum paints based on medium oil alkyd resin, or comaron resin, or similar vehicle.

19.5.2 Analysis of paint

Chemical analysis of paint shall be in accordance with Table 57.

19.5.3 Physical properties

The properties shall be in accordance with Table 58.

19.5.4 Working properties

Aluminum paint shall be capable of application by brush and spray. The painted surface shall show no running and shall present a uniform finish after drying.

TABLE 57 - ANALYSIS OF ALUMINUM PAINT

No.	CONTENT	UNIT	REQUIREMENTS	
			Type A	Type B
1	Aluminum pigment content (min.): - powder pigment, - paste pigment,	 g/lit g/lit	 240 300	 240 300
2	Total volatile content, (max.)	wt %	50	50
3	Acid content of drying oil, based on non-volatile vehicle, (min.)	wt %	55	—
4	Phthalic anhydride, percent by weight of nonvolatile vehicle, (min.)	wt %	20	—
5	Colophon resin and its derivatives	wt %	0	—
6	Water content, (max.)	wt %	0.2	0.2

TABLE 58 - PROPERTIES OF ALUMINUM PAINT

No.	PROPERTIES	REQUIREMENTS
1	Condition in container	Thickening, settling and separation are undesirable and objectionable if the paint cannot be reconditioned with a reasonable amount of stirring.
2	Viscosity (consistency) (Ford cup. No 4) - For brushing - For spraying	 30 - 50 sec. 20 - 30 sec.
3	Drying time (max) Type A Type B	 Surface-dry: 4 hr., hard-dry : 18 hr. Surface-dry: 8 hr., hard-dry : 18 hr.
4	Water-resistance	Shall be in accordance with ISIRI 1176
5	Flexibility	Shall be in accordance with ISIRI 1176
6	Leafing power	1) Leafing power for ready-mix paint shall be 100%, at seven days after delivery. 2) Leafing power for two-component paint one hour after mixing shall not be less than %95.

19.6 Swimming Pool Paint

19.6.1 Description

This Clause of the Standard covers specification of swimming pool paints based on styrene-acrylate copolymer resin in accordance with ISIRI 307. This paint shall be suitable for use in swimming pools and other concrete structures under damp conditions.

19.6.2 Analysis of paint

Water content of paint shall not be more than 0.5 by weight of paint.

19.6.3 Physical properties

The properties of swimming pool paint shall be in accordance with Table 59.

19.6.4 Working properties

Swimming pool paint shall be capable of application by brush. The paint shall present a uniform finish after drying.

TABLE 59 - PROPERTIES OF SWIMMING POOL PAINT

PROPERTIES	REQUIREMENTS
Condition in container	Thickening, settling and separation are undesirable and objectionable if the paint cannot be reconditioned with a reasonable amount of stirring.
Viscosity	125-200 KU (krebs unit)
Drying time: Surface-dry Hard-dry	 45 min. (max.) 24 hr. (max.)
Flexibility	If the sample tests is performed in accordance with ISIRI 307, no cracking shall be observed on paint surfaces.
Water-resistance and detergent-resistance	Shall be in accordance with ISIRI 307

19.7 Traffic Paint

19.7.1 Description

This Clause covers the specification of ready-mixed traffic paint that shall be suitable for use as reflecting traffic guide lines on paved roadways in accordance with ISIRI 339. Traffic paints are produced in yellow and white colors in following types:

a) Traffic paint with reflection

Glass beads shall be added to this type of traffic paint during production or after application on road. The glass beads would reflect automobile lights.

b) Traffic paint without reflection

In this type of traffic paint special pigments are added which to some extent reflect automobile lights.

19.7.2 Analysis of paint

Chemical analysis of traffic paint shall be in accordance with Table 60.

TABLE 60 - CHEMICAL ANALYSIS OF TRAFFIC PAINT

No.	CONTENT	PERMISSIBLE VOLUME
1	Total volatile content, max.	35 percent by weight
2	Pigment and extender content	40 to 55 percent by volume

19.7.3 Physical properties

The properties of traffic paint shall be in accordance with Table 61.

19.7.4 Working properties

Traffic paint shall be capable of application by brush and spray. The painted surface shall show no sagging and shall present a uniform finish after drying.

TABLE 61 - PROPERTIES OF TRAFFIC PAINT

No.	PROPERTIES	REQUIREMENTS
1	Condition in container	Thickening, settling and separation are undesirable and objectionable if the paint cannot be reconditioned with a reasonable amount of stirring.
2	Skinning	Sample tested in accordance with ISIRI 339 shall not contain any skin formation
3	Viscosity (consistency)	165 to 300 KU (krebs unit)
4	Hiding power and light reflection	Shall be in accordance with ISIRI 339
5	Drying time: Surface-dry Hard-dry	 15 min. (max.) 45 min. (max.)
6	Fineness of grind	50 μm max.
7	Flexibility	If the sample tests is performed in accordance with ISIRI 339, no cracking shall be observed on painted surface
8	Chalk-resistance	Shall be in accordance with ISIRI 339
9	Erosion-resistance	Shall be in accordance with ISIRI 339
10	Glass beads size	The glass beads shall have 80 to 100 percent (by weight) passing 850 μm (No. 20) sieve and retained over 250 μm (No. 60) sieve

19.8 Paints for Steel Structures

The paint systems used for steel structure consist of undercoat (primer), intermediate coat and top coat. Technical specifications for the three coats shall be in accordance to IPS Standards listed in Section 12 of this Standard.

20. WOODEN DOORS AND FURNITURE

20.1 Description

20.1.1 This Section of the Standard specifies the minimum requirements for single or double leaf doors in accordance with ISIRI 748. The doors can be "All Wood Doors" or "Glass and Wood Panel Doors".

20.1.2 They are available with or without split.

In each case, wooden doors consist of:

a) a steel frame;
b) signal or double wooden leaves;
c) several door hinges;
d) hardware such as a handle, fixed knob, furniture, door plates, etc.

20.2 Handing

The side that the hinges are on is the hand of the door. If the door swings away from the viewer, the hand is a regular hand, i.e. right or left hand.

If the door swings to the viewer, the door is reverse swing, i.e. right hand reverse swing or left hand reverse swing.

20.3 Dimensions

Dimensions of a single leaf door shall be in accordance with Table 62 and for a double leaf door it shall be accordance with Table 63.

TABLE 62 - DIMENSIONS OF SINGLE LEAF DOOR

DIMENSION OF DOOR WITH SPLIT (mm)				DIMENSIONS OF DOOR WITHOUT SPLIT (mm)			DIMENSION OF FRAME WITHOUT FRIEZE (mm)		DIMENSION OF DOOR SILL (mm)	
Thickness	Height	Width	Nominal size	Thickness	Height	Width	Height	Width	Height	Width
45	2100	675	700	41	2100	655	2200	725	2200	775
45	2100	775	800	41	2100	755	2200	825	2200	875
45	2100	875	900	41	2100	855	2200	925	2200	975
45	2100	975	1000	41	2100	955	2200	1025	2200	1075

TABLE 63 - DIMENSIONS OF DOUBLE LEAF DOOR

DIMENSION OF DOOR WITH SPLIT (mm)				DIMENSIONS OF DOOR WITHOUT SPLIT (mm)			DIMENSION OF FRAME (mm)	
Thickness	Height	Nominal size	Width	Thickness	Height	Width	Height	Width
45	2100	1100	657 + 405 775 + 305 775 + 405	40	2100	1060	2200	1130
45	2100	1200	875 + 305 875 + 405	40	2100	1160	2200	1230
45	2100	1300	975 + 305	40	2100	1260	2200	1330

20.4 Limit Value of Loading

20.4.1 Static load

When subjected to a static load, the door leaf shall not yield to an extent greater than that shown in Table 64.

20.4.2 Impact load accompanied by static load

When stressed as specified in Table 65, the door shall not be severely damaged or destroyed at any of the points of attack that entry into the area to be protected becomes possible.

This possibility is deemed to be given if:

- the door as a whole can be moved, or
- a through opening is created in the door leaf.

TABLE 64 - STATIC LOAD

LINE	POINT OF ATTACK ON DOORSET	LOAD F_R	YIELD OF PLANE OF DOOR LEAF OR OF DOOR PANEL IN THE DIRECTION OF LOAD
1	Plane of door leaf	6.0 kN	5 mm
2	All unsecured points including center of door leaf	3.0 kN	30 mm
3	For paneled doors, each panel corner	3.0 kN	5 mm
4	Lock (locks) *	6.0 kN	5 mm
5	Hinges *	6.0 kN	8 mm

*** In the case of more than one lock, latch or hinge being provided, each locking point shall be separately tested.**

TABLE 65 - IMPACT LOAD ACCOMPANIED BY STATIC LOAD

POINTS OF ATTACK ON DOOR LEAF	TYPE OF ATTACK	CHANGES OCCURRING IN DOORSET
On the main lock	Static load of $F_R = 3.0$ kN	No through opening in the door leaf; no destruction of locking points; no dropping out of the panels.
In the center of the panel and at all locking points	Impacts as described in ISIRI 748 using a sand-filled medicine ball of 30 kg mass, pendulum length 1500 mm, drop height 800 mm.	

20.5 Door Furniture

For specified requirements of door and window furniture see the following references:

a) Specification of hinges and pivots, see BS DD 171.
b) Specification of lock, latch handle and knob, see BS 4951.
c) Specification for thief resistant locks, see BS 3621.

21. ALUMINUM EXTRUDED PRODUCTS

21.1 General

21.1.1 This Section of the Standard covers aluminum alloy extruded shapes used for production of aluminum windows and doors in accordance with ISIRI 2384. (DIN 1748, sheet 1 and DIN 1725, sheet 1). Extruded shapes (profiles) are hollow or solid sections, long in relation to their cross-sectional dimensions, cross sections of which are shaped and are other than that of wire, rod, bar, or tube.

21.1.2 Aluminum extruded shapes include following types:

- Rectangular or square tube.
- Glass ledges (G).
- Coronet (C).
- Special technique (ST).
- U-shape (U).
- Cap (L).
- Facade (F).

21.1.3 The products covered by this section shall be produced by the hot extrusion methods.

21.1.4 The products shall be anodized.

21.1.5 Thickness of natural anodizing coating shall not be less than 10 μm and for colored anodizing coating shall not be less than 15 μm.

21.1.6 The aluminum alloy used for this section shall be "Al Mg Si - 0.5 (DIN)" equal to alloy 6060 (ASTM).

21.2 Physical Properties

21.2.1 Density of aluminum alloy shall be 2.72 kg/dm².

21.2.2 Hardness of aluminum shapes shall not be less than 10 degree of Webster (Rockwell E 66) and not more than 16 degree of Webster (Rockwell E 90).

21.3 Cross-sectional Dimensions and Tolerances

Cross-sectional dimensions and tolerances shall be in accordance with ISIRI 2384. (see Table 68 for dimensions of square and rectangular tube).

21.4 Nominal Weight

Nominal weight per length of extruded shapes shall be in accordance with Tables 68 and 69.

21.5 Chemical Composition

Chemical composition of aluminum alloys (Al MgSi - 0.5) shall be in accordance with Table 66.

21.6 Mechanical Properties

Mechanical properties of aluminum shapes shall be in accordance with Table 67.

TABLE 66 - CHEMICAL COMPOSITION OF ALUMINUM ALLOYS (Al Mg Si - 0.5)

ELEMENTS	PERMISSIBLE VALUE (wt%)
Magnesium (Mg) - limit	0.35 - 0.8
Silicon (Si) - limit	0.35 - 0.7
Iron (Fe) - max.	0.3
Copper (Cu) - max.	0.1
Manganese (Mn) - max.	0.1
Chromium (Cr) - max.	0.05
Zinc (Zn) - max.	0.15
Titanium (Ti) - max.	0.1
Other elements - max.	0.05 - 0.15

TABLE 67 - MECHANICAL PROPERTIES OF ALUMINUM ALLOYS (Al Mg Si - 0.5)

PROPERTIES	PERMISSIBLE VALUE		
	Type F-13	Type F-22	Type F-25
	Age-hardened	Quench age hardened	Quench age hardened
Thickness - mm	All	All	All
Tensile strength N/mm² (kg/mm²)	130 (13)	215 (22)	245 (25)
Yield strength (0.2% offset) min. N/mm² (kg/mm²)	65 (7)	160 (16)	195 (20)
Elongation [1] min %			
A	15	12	10
A 50 mm	13	10	8
Typical brinell hardness HB	45	70	75

[1] For elongation two different gage lengths are used. The choice of the gage length for elongation measurements (A or A50 mm) is at the discretion of the producer, unless otherwise agreed.

A: Percentage elongation on a gage length of $5.65\sqrt{S}$

A 50 mm : Percentage elongation on a gage length of 50 mm.

TABLE 68 - DIMENSIONS OF SQUARE AND RECTANGULAR TUBES

TYPES	CROSS-SECTIONAL DIMENSION (mm)	THICKNESS (mm)	TOLERANCES (mm)	NOMINAL WEIGHT PER 1 m OF LENGTH (g/m)
0 - 100	5 × 35	2		605
0 - 101	35 × 35	2	+0.2	720
0 - 102	40 × 40	2	-0.25	820
0 - 103	45 × 45	2		930
0 - 104	35 × 55	2.5	for	1160
0 - 105	25 × 64	2	all	920
0 - 106	38 × 64	2.5	types	1310
0 - 107	40 × 80	2.5		1570
0 - 108	45 × 100	2.5		1905

TABLE 69 - NOMINAL WEIGHT OF EXTRUDED SHAPES PER ONE METER OF LENGTH

TYPE OF SHAPES	NOMINAL WEIGHT (g/m)	TYPE OF SHAPES	NOMINAL WEIGHT (g/m)
U-shape, U.42	148	Special techniques:	
Glass ledge, G 29	202	ST-100	1135
- Cap - L.36	360	ST-102	1295
- Cap - L.52	388	ST-103	1280
- Cap - K.09	240	ST-107	323
Coronet C.01	710	ST-114	1110
Coronet C.02	962	ST-118	200
Coronet C.03	697	ST-119	1150
Coronet C.04	1315	ST-123	390
Coronet C.05	1020	ST-125	1140
Coronet C.10	285	ST-126	1095
Coronet C.10 & 11	1365	ST-125-6	1135
Coronet C.12	735	ST-131	1100
Coronet C.13	1135	ST-132	830
Coronet C.16	915	ST-133	1200
Coronet C.17	705	ST-134-5	1320
Coronet C.18	553	ST-136	1520
Coronet C.19	520	ST-148	295
Coronet C.30	2040	Facade F.01	940
Coronet C.36	1155	Facade F.02	590
		Facade F.04	635

22. STRUCTURAL STEEL-GENERAL

22.1 Most of the steel used for construction contain low-to medium carbon and are relatively mild, tough, and strong; fairly easy to work by cutting punching, riveting and welding. Prestressed concrete imposes special requirements for reinforcing steel. It must be of high strength with a high yield point and minimum creep in the working range.

22.2 The specification of following types of structural steel are described in this Standard:

- **a)** Steel bars (Section 23).
- **b)** Steel wires (Section 24).
- **c)** Zinc coated steel plate, (Section 25).
- **d)** Hot-rolled steel I-beams (Section 26).
- **e)** Steel channel sections (Section 27).
- **f)** Steel Tee sections (Section 28).
- **g)** Steel angle sections (Section 29).
- **h)** Steel round edge zeds (Section 30).
- **i)** Steel hollow sections (Section 31).

22.3 The value of mass for structural steel have been calculated by taking a density of 7.85 kg/dm³.

22.4 The dimensions, weight, chemical analysis, and mechanical properties of structural steel are described in sections 23 to 31.

22.5 The Purchaser or Company may specify additional requirements that do not negate any of the provisions of this section or of the individual material specifications. Such additional requirements, the acceptance of which are subject to negotiation with the supplier, must be included in the purchase order.

22.6 The material shall be free of injurious defects and shall have a workmanlike finish.

22.7 Packaging, marking and loading for shipment shall be in accordance with procedures recommended by ASTM A 700-1981.

23. STRUCTURAL STEEL-BARS

23.1 General

The steel bar is an elongated piece of metal of simple, uniform cross-section; usually circular, rectangular or square, produced by forging or hot rolling.

This Section specifies requirements of the following types of steel bars used for the reinforcement of concrete:

a) Uncoated round steel bars-plain and deformed (23.2).
b) Prestressing steel bars-plain and deformed (23.3).
c) Flat steel bars (23.4).
d) Square steel bars (23.5).
e) Galvanized steel bars (23.6).
f) Fabricated deformed steel bar mats (23.7).

23.2 Uncoated Round Steel Bars (Plain and Deformed)

23.2.1 Description

This Clause covers deformed and plain steel bars used as concrete-reinforcement, in accordance with ISIRI 1797 and ASTM A 615-M. A deformed bar is defined as a bar that is intended for use as reinforcement in reinforced concrete construction. The surface of the deformed bar is provided with lugs or protrusions (deformations) which inhibit longitudinal movement of the bar relative to the concrete which surrounds the bar in such construction, in conformance to the provisions of this Standard. Bars are of three minimum yield levels: namely 300, 400 and 500 MPa, designated as Grades 300, 400 and 500 respectively.

Note:

The specification of low alloy steel deformed bar for concrete reinforcement covers special applications, where welding or blending, or both of bars and their number designations are of importance. The standard sizes and dimensions shall be those listed in Tables 70 and 71.

23.2.2 Dimensions

23.2.2.1 Plain bars

Dimensions of plain round bars shall be in accordance with ISIRI 1797 (see Table 75). The tolerances on the dimensions shall be in accordance with ISO 1035/4.

23.2.2.2 Deformed bars

Deformed bars are listed in eight sizes; from size No. 10 to size No. 55, in accordance with ASTM A 615 M. The spacing, height and gap of deformations shall conform to the requirements prescribed in Table 76.

23.2.3 Chemical compositions

The phosphorus content determined in heat analysis, shall not exceed 0.06 %.

23.2.4 Mechanical properties

- Tensile requirement, yield strength and percentage of elongation shall be as prescribed in Table 72.

- The bend-test specimen shall with stand being bent around a pin without cracking on the outside of the bent portion. The requirements for degree of bending and sizes of pins are prescribed in Table 73.

TABLE 70 - DIMENSIONS OF PLAIN ROUND BARS

DIAMETER mm	SECTIONAL AREA cm²	MASS [1] PER UNIT LENGTH kg/m	DIAMETER mm	SECTIONAL AREA cm²	MASS [1] PER UNIT LENGTH kg/m
5	0.198	0.154	40	12.6	9.85
6	0.283	0.222	45	15.9	12.5
8	0.503	0.395	50	19.6	15.4
10	0.785	0.617	55	23.8	18.7
12	1.13	0.888	56	24.6	19.3
14	1.54	1.21	63	31.2	24.5
16	2.01	1.58	70	38.5	30.2
18	2.54	2.00	80	50	39.5
20	3.14	2.47	90	63.6	49.9
22	3.80	2.98	100	78.5	61.7
25	4.91	3.85	110	95	74.6
28	6.16	4.83	125	123	96.3
30	7.07	5.55	140	154	121
32	8.04	6.31	160	201	158
36	10.2	7.99	180	254	200
			200	314	247

[1] The value of Mass is based on density of steel = 7.86 kg/dm³

TABLE 71 - DEFORMED BAR DESIGNATION NUMBERS, NOMINAL MASSES, NOMINAL DIMENSIONS, AND DEFORMATION REQUIREMENTS

		NOMINAL DIMENSIONS [A]			DEFORMATION REQUIREMENTS mm		
Bar Designation No. [B]	Nominal Mass kg/m	Diameter mm	Cross Sectional Area mm²	Perimeter mm	Maximum Average Spacing	Maximum Average Height	Maximum gap (chord of 12.5% of nominal perimeter)
10	0.785	11.3	100	35.5	7.9	0.45	4.4
15	1.570	16.0	200	50.3	11.2	0.72	6.3
20	2.355	19.5	300	61.3	13.6	0.98	7.7
25	3.925	25.2	500	79.2	17.6	1.26	9.9
30	5.495	29.9	700	93.9	20.9	1.48	11.7
35	7.850	35.7	1000	112.2	25.0	1.79	14.0
45	11.775	43.7	1500	137.3	30.6	2.20	17.2
55	19.625	56.4	2500	177.2	39.4	2.55	22.2

A) The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same mass per meter as the deformed bar.

B) Bar designation numbers approximate the number of millimeters of the nominal diameter of the bar.

TABLE 72 - TENSILE REQUIREMENTS

Tensile strength, min, MPa Yield strength, min, MPa	GRADE 300 A)	GRADE 400	GRADE 500 B)
	500 300	600 400	700 500
Elongation in 200 mm, min,%: Bar No.			
10	11	9	—
15.20	12	9	—
25	—	8	—
30	—	7	—
35, 45, 55	—	7	6

A) Grade 300 bars are furnished only in sizes 10 through 20.
B) Grade 500 bars are furnished only in sizes 35, 45, and 55.

TABLE 73 - BEND TEST REQUIREMENTS

BAR DESIGNATION No.	PIN DIAMETER FOR BEND TESTS A)		
	Grade 300	Grade 400	Grade 500
10, 15	3½ d B)	3½ d	—
20	5d	5d	—
25	—	5d	—
30	—	7d	—
35	—	7d	7d
45, 55 (90°)	—	9d	9d

A) Test bends 180° unless noted otherwise.
B) d = nominal diameter of specimen.

23.3 Prestressing Steel Bars (Plain and Deformed)

23.3.1 Description

This Clause covers uncoated high-strength steel bars intended for use in prestressed concrete construction in accordance with ASTM A 722. Bars are of a minimum ultimate tensile strength level of 1035 MPa (150,000 psi).

Two types of bars are provided as follows:

Type I : Prestressing bar has a plain surface.
Type II: Prestressing bar has surface deformations.

23.3.2 Dimensions

The standard sizes and dimensions of type I and II bars shall be those listed in Tables 74 and 75 respectively.

For type I bars, the permissible variation from the nominal diameter specified in Table 78 shall not exceed +0.76 to -0.25 mm.

For type II bars, the permissible variation from the nominal weight specified in Table 75 shall not exceed +3% to -2%. The minimum height and projected area of deformations shall conform to the requirements shown in Table 76.

23.3.3 Chemical requirements

On heat analysis, phosphorus and sulfur of prestressing steel bars shall not exceed the following:

Phosphorus	0.040%
Sulfur	0.050%

23.3.4 Mechanical requirements

23.3.4.1 Tensile properties

Finished bars shall have a minimum ultimate tensile strength of 1035 MPa (150,000 psi).

23.3.4.2 Yield strength

The minimum yield strength of Type I an Type II bars shall be 85% and 80%, respectively of the minimum ultimate tensile strength of the bars.

23.3.4.3 Elongation after rupture

The minimum elongation after rupture shall be 4.0% in a gage length equal to 20 bar diameters, or 7.0% in a gage length equal to 10 bar diameters.

23.3.4.4 Requirements for deformations

The average spacing or distance between deformations on both sides of the bar shall not exceed ($^{7}/_{10}$) seven tenths of the nominal diameter of the bar.

TABLE 74 - DIMENSIONS FOR TYPE I (PLAIN) BAR

NOMINAL DIAMETER		NOMINAL WEIGHT		NOMINAL AREA [A)]	
in.	mm	1b/ft	kg/m	in.²	mm²
$^{3}/_{4}$	19	1.50	2.23	0.44	284
$^{7}/_{8}$	22	2.04	3.04	0.60	387
1	25	2.67	3.97	0.78	503
$1^{1}/_{8}$	29	3.38	5.03	0.99	639
$1^{1}/_{4}$	32	4.17	6.21	1.23	794
$1^{3}/_{8}$	35	5.05	7.52	1.48	955

[A)] The nominal area is determined from the nominal diameter in inches. Values have been converted from inch-pound units to metric units.

TABLE 75 - DIMENSIONS FOR TYPE II (DEFORMED) BAR

NOMINAL DIAMETER [A]		NOMINAL WEIGHT		EFFECTIVE AREA [B]	
in.	mm	1b/ft	kg/m	in.²	mm²
5/8	15	0.98	1.46	0.28	181
3/4	19	1.49	2.22	0.42	271
1	25	3.01	4.48	0.85	548
1 1/4	32	4.39	6.54	1.25	806
1 3/8	35	5.56	8.28	1.58	1019

A) Nominal diameters are for identification only. Values have been converted from metric to inch-pound units.
B) The effective area is determined from the bar weight less 3.5 % for the ineffective weight of the deformations.

TABLE 76 - DEFORMATION DIMENSIONS FOR TYPE II BAR

NOMINAL DIAMETER		DEFORMATION DIMENSIONS					
		MAXIMUM AVERAGE SPACING		MAXIMUM AVERAGE HEIGHT		MINIMUM PROJECTED AREA [A]	
in.	mm	in.	mm	in.	mm	in.²/in.	mm²/mm
5/8	15	0.437	11.10	0.028	0.71	0.094	2.41
3/4	19	0.525	13.34	0.038	0.96	0.130	3.40
1	25	0.700	17.78	0.050	1.27	0.168	4.39
1 1/4	32	0.887	22.52	0.064	1.62	0.212	5.40
1 3/8	35	0.987	25.07	0.071	1.80	0.233	6.08

A) Calculated from equation, MPA = 0.75 πd h/s

Where:

d = nominal diameter,
h = minimum average height, and
s = maximum average spacing.

23.4 Flat Steel bars

23.4.1 Description

Flat bars are the steel product, produced in straight lengths of steel in uniform rectangular cross sections.

This Clause specifies the requirements of flat steel bars in accordance with ISO 1035/3.

23.4.2 Dimension

The dimensions of flat bars are given in Table 77. The tolerances on the dimensions shall be the normal tolerances specified in ISO 1035/4.

23.4.3 Properties

The chemical and physical properties of flat bars shall be in accordance with ISIRI 1600.

TABLE 77 - DIMENSION AND MASSES OF FLAT BARS

WIDTH**	MASS, * kg/m FOR THICKNESS** OF										
	5	6	8	10	12	15	20	25	30	40	50
	PREFERRED SIZES										
20	0.785	0.942	1.26	1.57	—	—	—	—	—	—	—
25	0.981	1.18	1.57	1.96	2.63	—	—	—	—	—	—
30	1.18	1.41	1.88	2.36	2.83	3.53	4.71	—	—	—	—
35	1.37	1.65	2.20	2.75	3.30	4.12	5.50	—	—	—	—
40	1.57	1.88	2.51	3.14	3.77	4.71	6.28	—	—	—	—
45	1.77	2.12	2.83	3.53	4.24	5.30	7.07	—	—	—	—
50	1.96	2.36	3.14	3.93	4.71	5.89	7.85	9.81	11.8	—	—
60	2.36	2.83	3.77	4.71	5.65	7.07	9.42	11.8	14.1	—	—
70	2.75	3.30	4.40	5.50	6.59	8.24	11.0	13.7	16.5	—	—
80	3.14	3.77	5.02	6.28	7.54	9.42	12.6	15.7	18.8	25.1	—
90	3.53	4.24	5.65	7.07	8.48	10.6	14.1	17.7	21.2	28.3	—
100	3.93	4.71	6.28	7.85	9.42	11.8	15.7	19.6	23.6	31.4	—
120	—	5.65	7.54	9.42	11.3	14.1	18.8	23.6	28.3	37.7	47.1
150	—	7.07	9.42	11.8	14.1	17.7	23.6	29.4	35.3	47.1	58.9
SECOND PREFERENCE SIZES											
16	0.628	0.754	1.00	1.26	1.51	—	—	—	—	—	—
20	—	—	—	—	1.88	2.36	—	—	—	—	—
25	—	—	—	—	—	2.94	—	—	—	—	—
40	—	—	—	—	—	—	—	7.85	9.42	—	—
45	—	—	—	—	—	—	—	8.83	10.6	—	—
60	—	—	—	—	—	—	—	—	—	18.8	—
65	2.55	3.06	4.08	5.10	6.12	7.65	10.2	12.8	15.3	20.4	—
70	—	—	—	—	—	—	—	—	—	22.0	—
75	2.94	3.53	4.71	5.89	7.07	8.83	11.8	14.7	17.7	23.6	—
80	—	—	—	—	—	—	—	—	—	—	31.4
90	—	—	—	—	—	—	—	—	—	—	35.3
100	—	—	—	—	—	—	—	—	—	—	39.2
130	—	6.12	8.16	10.2	12.2	15.3	20.4	25.6	30.6	40.8	51.2
140	—	6.59	8.79	11.0	13.2	16.5	22.0	27.5	33.0	44.0	55.0

*** The values of mass are based on a density of steel of 7.85 kg/dm³.**

**** Dimensions are in millimeters.**

23.5 Square Steel Bars

23.5.1 Description

Square steel bars are the steel products, produced in straight lengths of steel in uniform square cross-sections.

This Clause specifies the requirements for square steel bars in accordance with ISO 1035/2.

23.5.2 Dimension

The dimensions of square bars are given in Table 78.

Tolerances on the dimensions shall be the normal tolerances specified in ISO 1035/4. The corner radii of square steel bars are shown in Table 79.

23.5.3 Properties

The chemical and physical properties of square bars shall be in accordance with ISIRI 1600.

TABLE 78 - DIMENSIONS, SECTIONAL AREAS AND MASSES OF SQUARE BARS

PREFERRED SIZES			SECOND-PREFERENCE SIZES		
Width mm	Sectional area cm²	Mass [1] per unit length kg/m	Width mm	Sectional area cm²	Mass [1] per unit length kg/m
8	0.64	0.502	28	7.84	6.15
10	1.00	0.785	32	10.2	8.04
12	1.44	1.13	45	20.2	15.9
14	1.96	1.54	55	30.2	23.7
16	2.56	2.01	90	81.0	63.6
18	3.24	2.54			
20	4.00	3.14			
22	4.84	3.80			
25	6.25	4.91			
30	9.00	7.06			
35	12.2	9.58			
40	16.0	12.6			
50	25.0	19.6			
60	36.0	28.3			
70	49.0	38.5			
80	64.0	50.2			
100	100	78.5			
120	144	113			

1) The values of mass are given for information only and are based on a density of steel of 7.85 kg/dm³.

TABLE 79 - CORNER RADII FOR SQUARE BARS

SIZES		Corner radii r max. (mm)
Over (mm)	Up to and including (mm)	
—	12	1.0
12	20	1.5
20	30	2.0
30	50	2.5
50	100	3.0
100	120	4.0

23.6 Galvanized (Zinc-Coated) Steel Bars

23.6.1 Description

This Clause specifies the requirements of concrete reinforcing bars, deformed and plain, with protective zinc coatings applied by dipping the properly prepared reinforcing bars into a molten bath of zinc in accordance with ASTM A 767-88.

23.6.1.1 Weight of coating

Two classes of coating weights, based on actual area of bar are shown in Table 80.

The weight of coating shall be determined by stripping specimens taken from sample bars or by magnetic thickness gage measurements.

The zinc coating shall have no bare spots. The coating shall be free of blisters, flux spots or inclusions, dross and acid or black spots.

23.6.2 Properties

The coating shall be adherent so it cannot be removed by any reasonable process of handling or erection.

23.6.3 Supplementary requirements

The following supplementary requirements shall apply when specified in the purchase order or contract:

- Sheared ends shall be coated with a zinc-rich epoxy paint (IPS-M-TP-205.)
- Damage of the coating as a result of bending shall be repaired with a zinc-rich paint.

TABLE 80 - WEIGHT OF ZINC

COATING CLASS	WEIGHT OF ZINC COATING, min, g/m² of surface
Class I Bar designation size No. 10 and larger	1070
Class II Bar designation size No. 10 and larger	610

23.7 Fabricated Deformed Steel Bar Mats

23.7.1 Description

This Clause covers material in mat (or sheet) form fabricated from hot-rolled deformed steel bars to be used for the reinforcement of concrete in accordance with ASTM A 184-88. The mats shall consist of two layers of bars that are assembled at right angles to each other. Mats may be assembled by clipping or welding at the intersections.

23.7.2 Material

- Deformed steel bars grades 300, 350, 400 used in the manufacture of clipped mats shall conform to clause 23.2 (round bars) of this Section.

- Deformed steel bars of grades 300 used in the manufacture of welded mats shall also conform to clause 23.2 of this Section.

23.7.3 Assembly

Mats shall be assembled by means of welding or clipping to provide attachment at intersections.

23.7.3.1 Welds

Welds at intersections shall be made in a workmanlike manner and shall provide attachment at all exterior intersections and at not less than alternate interior intersections.

The separation of 5% or less of all welded intersections of any mat shall not be cause for rejection provided that no more than half of the welds on any one bar are separated.

Welding shall be done in such a manner that the minimum tensile strength, yield strength and elongation requirements shall be met when a specimen is tested across a point of weld.

23.7.3.2 Clips

Clips for clipped mats shall be formed mechanically prior to or during the fabrication and assembly of the mats. They shall engage and attach both bars at any intersection in such manner that separation in normal handling is prevented and the assembly conforms to the requirements specified for physical tests of attachment at intersections.

23.7.4 Dimensions

23.7.4.1 The sizes, spacings, dimensions and arrangement of the bar mats shall conform to the design specified by the Purchaser.

Bars shall extend beyond exterior intersections a distance of not less than 25 mm. The spacing of bars shall average that specified in the design, and the space between individual bars shall not vary more than 6 mm from that specified.

23.7.4.2 The overall length or width of mats shall not be more than 25 mm greater or less than the specified dimensions.

23.7.4.3 Width and length tolerances

The overall length or width of the mats shall not be more than 25 mm greater or less than the specified dimension.

23.7.5 Mechanical properties

Strength of connections in welded or clipped deformed bar mats shall be considered satisfactory compliance with this standard if connections made by clipping shall be capable of withstanding a static load of 335 N exerted in the direction of either bar, with not more than 13 mm slip; and, on either clipped or welded mats, a static load of 670 N exerted perpendicular to the plane of the mat tending to separate the bars, with no apparent loosening when applied to one intersection of connected bars.

24. STRUCTURAL STEEL-WIRES

24.1 General

Wire is a steel product of any form of cross section produced by cold reduction of an as-rolled rod.

24.1.1 This Section specifies requirement of the following types of steel wire used for the reinforcement of concrete and for the manufacture of various steel wire fabrics.

a) Plain steel wire (24.2).
b) Deformed steel wire (24.3).
c) Prestressing steel wire (24.4).
d) Steel welded plain wire fabric (24.5).

e) Steel welded deformed wire fabric (24.6).
f) Barbed steel wire (24.7).
g) Seven-wire steel strand (24.8).
h) Zinc-coated steel chain-link fence fabric(24.9).

24.1.2 Method of storage and packaging of steel wire shall be in accordance with ASTM A-700.

24.1.3 Method of testing of steel wire shall be in accordance with ISIRI 2097.

24.2 Plain Steel Wire

24.2.1 Description

This Clause covers cold-drawn steel wire, as drawn or galvanized, to be used as such or in fabricated form for the reinforcement of concrete, in sizes not less than 2.03 mm nominal diameter in accordance with ASTM A 82-88.

24.2.2 Dimensions

When wire for concrete reinforcement is ordered by size number, the relation between size number, diameter and area shall apply as shown in Table 81.

24.2.3 Mechanical property requirements

24.2.3.1 Tension test for plain steel wire shall conform to the tensile property requirements in Table 82 based on nominal area of wire. For material to be used in the fabrication of welded fabric, the tensile and yield strength properties shall conform to the requirements given in Table 83.

24.2.3.2 Bend test

The bend test specimen shall stand being bent at room temperature through 180°C without cracking on the outside of the bent portion, as prescribed in Table 84.

TABLE 81 - DIMENSIONS OF PLAIN STEEL WIRE

SIZE NUMBER	NOMINAL DIAMETER, mm	NOMINAL AREA mm²
W 0.5	2.03	3.23
W 1.2	3.15	7.74
W 1.9	3.40	9.08
W 2	4.06	12.90
W 2.5	4.52	16.13
W 2.9	4.88	18.70
W 3.5	5.36	22.58
W 4	5.74	25.81
W 4.5	6.07	29.03
W 5	6.40	32.26
W 5.5	6.73	35.48
W 6	7.01	38.71
W 8	8.10	51.61
W 10	9.07	64.52
W 12	9.93	77.42
W 14	10.72	90.32
W 16	11.46	103.25
W 18	12.17	116.13
W 20	12.83	129.03
W 22	13.44	141.90
W 24	14.05	154.80
W 26	14.61	167.70
W 28	15.16	180.60
W 30	15.70	193.50
W 31	15.95	200.0

These sizes represent the most commonly used items in both welded wire fabric and wire usage.

TABLE 82 - TENSION TEST REQUIREMENTS FOR PLAIN STEEL WIRE

Tensile strength, min. (MPa)	550
Yield strength, min. (MPa)	485
Reduction of area, min. %	30 A)

A) For material testing over 690 MPa tensile strength, the reduction of area shall be not less than 25 %.

TABLE 83 - TENSION TEST REQUIREMENTS (MATERIAL FOR WELDED FABRIC)

	SIZE W 1.2 AND LARGER	SMALLER THAN SIZE W 1.2
Tensile strength, min. (MPa)	515	485
Yield strength, min. (MPa)	450	385

TABLE 84 - BEND, TEST REQUIREMENTS

SIZE NUMBER OF WIRE	BEND TEST
W7 and smaller	Bend around a pin the diameter that is equal to the diameter of the specimen
Coarser than W7	Bend around a pin the diameter that is equal to twice the diameter of the specimen

24.3 Deformed Steel Wire

24.3.1 Description

This Clause covers cold-worked, deformed steel wire to be used as such, or in fabricated form, for the reinforcement of concrete in sizes having nominal cross-sectional area not less than 6.45 mm² nor greater than 200 mm² in accordance with ASTM A 498.

24.3.1.1 Dimensions

Dimensional requirements of deformed steel wire shall be in accordance with Table 85.

24.3.2 Mechanical property requirements

24.3.2.1 Tension test

When tested the material shall conform to the tensile property requirements of Table 86, based on nominal area of wire. For material to be used in the fabrication of welded fabric the tensile and yield strength properties shall conform to the requirements given in Table 87 based on nominal area of the wire.

24.3.2.2 Bend test

The bend test specimen shall stand being bent at room temperature through 90° without cracking on the outside of the bent portion , as prescribed in Table 88.

TABLE 85 - DIMENSIONAL REQUIREMENTS FOR DEFORMED STEEL WIRE

		NOMINAL DIMENSIONS			DEFORMATION REQUIREMENTS		
Deformed Wire Size Number [A) B)]	Unit Weight kg/m	Diameter mm [C)]	Cross Sectional Area mm² [D)]	Perimeter mm	Maximum mm	Minimum mm	Minimum Average Height of Deformation mm [E)]
D 1	0.0510	2.87	6.45	9.02	7.24	4.62	0.114
D 2	0.1013	4.04	12.90	12.67	7.24	4.62	0.160
D 3	0.1523	4.95	19.35	15.54	7.24	4.62	0.198
D 4	0.2025	5.27	25.81	17.93	7.24	4.62	0.257
D 5	0.2532	6.40	32.26	20.09	7.24	4.62	0.287
D 6	0.3038	7.01	38.71	22.02	7.24	4.62	0.315
D 7	0.3548	7.57	45.16	23.77	7.24	4.62	0.340
D 8	0.4051	8.10	51.61	25.45	7.24	4.62	0.363
D 9	0.4561	8.59	58.96	26.95	7.24	4.62	0.386
D 10	0.5063	9.04	64.52	28.40	7.24	4.62	0.406
D 11	0.5574	9.50	70.97	29.82	7.24	4.62	0.475
D 12	0.6076	9.91	77.42	31.12	7.24	4.62	0.495
D 13	0.6586	10.31	83.87	32.39	7.24	4.62	0.516
D 14	0.7089	10.72	90.32	33.66	7.24	4.62	0.536
D 15	0.7599	11.10	96.77	34.85	7.24	4.62	0.554
D 16	0.8101	11.46	103.23	35.97	7.24	4.62	0.572
D 17	0.8611	11.81	109.68	37.08	7.24	4.62	0.589
D 18	0.9114	12.14	116.13	38.13	7.24	4.62	0.607
D 19	0.9624	12.47	122.58	39.17	7.24	4.62	0.622
D 20	1.0127	12.80	129.03	40.21	7.24	4.62	0.640
D 21	1.0637	13.13	135.48	41.25	7.24	4.62	0.658
D 22	1.1139	13.44	141.94	42.21	7.24	4.62	0.673
D 23	1.1649	13.74	148.39	43.18	7.24	4.62	0.688
D 24	1.2152	14.05	154.84	44.12	7.24	4.62	0.704
D 25	1.2662	14.33	161.29	45.01	7.24	4.62	0.716
D 26	1.3164	14.61	167.74	45.87	7.24	4.62	0.732
D 27	1.3675	14.88	174.19	46.76	7.24	4.62	0.744
D 28	1.4177	15.16	180.64	47.65	7.24	4.62	0.759
D 29	1.4687	15.44	187.10	48.51	7.24	4.62	0.772
D 30	1.5190	15.70	193.55	49.33	7.24	4.62	0.785
D 31	1.5700	15.95	200.00	50.11	7.24	4.62	0.798

A) The number following the prefix D identifies the nominal cross-sectional area of the deformed wire in hundredths of a square inch.

B) For sizes other than those listed above, the size number shall be the number of one hundredths of a square inch in the nominal area of the deformed wire cross section, prefixed by the letter "D".

C) The nominal diameter of a deformed wire is equivalent to the diameter of a plain wire having the same weight per foot as the deformed wire.

D) The cross-sectional area is based on the nominal diameter. The area in square inches may be calculated by dividing the weight per lineal inch of the specimen in pounds by 0.2833 (weight of 1 in.³ of steel), or by dividing the weight per lineal foot of specimen in pounds by 3.4 (weight of steel 1 in. square and 1 ft long).

E) The minimum average height of the deformations shall be determined from measurements made on not less than two typical deformations from each line of deformations on the wire. Measurements shall be made at the center of indentations.

TABLE 86 - TENSION TEST REQUIREMENTS FOR DEFORMED STEEL WIRE

STRENGTH	MPa min (center)
Tensile Yield	585 515

TABLE 87 - TENSION TEST REQUIREMENTS (MATERIAL FOR WELDED FABRIC)

STRENGTH	MPa min (center)
Tensile Yield	550 485

TABLE 88 - BEND TEST REQUIREMENTS

SIZE NUMBER OF WIRE	BEND TEST
D-6 and smaller	Bend around a pin the diameter that is equal to twice the diameter of the specimen
Coarser than D-6	Bend around a pin the diameter that is equal to four times the diameter of the specimen

24.4 Prestressing Steel Wire

24.4.1 Description

This Clause specifies the requirements of uncoated, stress-relieved round, high-carbon steel wire commonly used in prestressed linear concrete construction in accordance with ASTM A 421-80 (88). Prestressing steel wires consist of two types as follows:

Type BA (Button anchorage)

This type of wire is used for applications in which cold-end deformation is used for anchoring purposes.

Type WA (wedge anchorage)

This type of wire is used for applications in which the ends are anchored by wedges and no cold-end deformation of the wire is involved.

24.4.2 Dimensions

24.4.2.1 Dimensions of prestressing wire shall be in accordance with Table 89.

24.4.2.2 The diameter of the wire shall not vary from the nominal diameter specified by more than 0.05 mm.

24.4.2.3 The wire shall not be out-of-round by more than 0.05 mm.

24.4.3 Chemical requirements

Phosphorus and sulfur values of sample shall not exceed the following:

Phosphorus	0.040%
Sulfur	0.050%

24.4.4 Physical properties

24.4.4.1 Tensile strength

The tensile strength of types BA and WA wire shall conform to the requirements prescribed in Table 90.

24.4.4.2 Yield strength

The initial load corresponding to the initial stress prescribed in Table 97 shall be applied to the specimen, at which time the extensometer is attached and adjusted to a reading of 0.001 in./in. of gage length. The load shall then be increased until the extensometer indicates and extension of 1%. The load for this extension shall be recorded. The stress corresponding to this load shall meet the requirements for stress at 1% extension prescribed in Table 91.

24.4.4.3 Elongation

The total elongation under load of all wire shall not be less than 4.0% when measured in a gage length of 250 mm. The initial stress is prescribed in Table 92.

TABLE 89 - DIMENSIONS OF PRESTRESSING WIRE

NOMINAL DIAMETER mm	NOMINAL AREA mm²	NOMINAL WEIGHT kg/m
4.88	18.7	0.146
4.98	19.4	0.149
6.35	32	0.253
7.01	39	0.298

TABLE 90 - TENSILE STRENGTH REQUIREMENTS

NOMINAL DIAMETER mm	TENSILE STRENGTH, min (MPa)	
	Type BA	Type WA
4.88	A)	1725
4.89	1655	1725
6.35	1655	1655
7.01	1620	1620

A) This size is not commonly furnished in Type BA wire.

TABLE 91 - YIELD STRENGTH REQUIREMENTS

NOMINAL DIAMETER mm	INITIAL STRESS	MINIMUM STRESS AT 1% EXTENSION, (MPa)	
		Type BA	Type WA
4.88	200	A)	1465
4.89	200	1407	1465
6.35	200	1407	1407
7.01	200	1377	1377

A) This size is not commonly furnished in Type BA wire.

24.5 Steel Welded Plain Wire Fabric

24.5.1 Description

This Clause covers welded wire fabric to be used for the reinforcement of concrete in accordance with ASTM A 185-85. Welded wire fabric, designates a material composed of cold-drawn steel wire as-drawn or galvanized, fabricated into sheets or rolls by the process of electric resistance welding. The finished material shall consist essentially of a series of longitudinal and transverse wires arranged substantially at right angles to each other, and welded together at points of intersection.

The wire used in the manufacturer of welded wire fabrics shall conform to specification "Plain steel wire" (24.2).

24.5.2 Dimensions

24.5.2.1 Width

The permissible variation shall not exceed 13 mm greater or less than the specified width.

24.5.2.2 Length

The overall length of flat sheets may vary ±25 mm or 1% whichever is greater.

24.5.2.3 Diameter

The permissible variation in diameter of any wire in the fabric shall conform to the tolerances prescribed for plain steel wire (24.2) with the following exceptions:

a) The out-of-round requirements shall not apply.
b) Unless otherwise precluded by the Purchaser, the manufacturer will be permitted to apply oversized wire (not undersized).

24.5.2.4 Spacing of wires

The center-to-center distance between individual members may vary not more than 6.35 mm from the specified spacing.

24.5.3 Mechanical property requirements

24.5.3.1 Tensile, reduction of area bend test

Tensile, reduction of area and bend test are normally done at the time the wire is drawn. The wire shall meet the requirements prescribed in section 24.2.

24.5.3.2 Weld shear strength

The minimum average shear value in Newtons, shall not be less than 241, multiplied by the nominal area in square millimeters, where the smaller wire is not less than size W 1.2 and has an area of 40% or more of the area of larger wire.

The fabric will be acceptable if the average of all weld shear test values across the specimen meets the prescribed minimum value.

24.6 Steel Welded Deformed Wire Fabric

24.6.1 Description

This Clause covers welded wire fabric made from cold worked deformed wire, or a combination of deformed and non-deformed wires, to be used for the reinforcement of concrete, in accordance with ASTM A 497.

24.6.2 The wire used in the manufacture of welded wire fabrics shall conform to specification for "Deformed Steel Wire" (24.3).

24.6.3 Dimensions and weight

24.6.3.1 Width

The permissible variation shall not exceed 13 mm greater or less than the specified width.

24.6.3.2 Length

The overall length of flat sheets may vary 25 mm or 1% whichever is greater.

24.6.3.3 Spacing of wires

The center-to center distance between individual members may vary not more than 6.35 mm from the specified spacing.

24.6.4 Mechanical property requirements

24.6.4.1 Tensile, reduction of area and bend test

Tensile, reduction of area and bend tests are normally done at the time the wire is drawn. The wire shall meet the requirements prescribed in clause 24.3.

24.6.4.2 Weld shear strength

The minimum average shear value in Newtons shall not be less than 138 multiplied by the nominal area in square millimeters, where the smaller wire is not less than size D4 (see 24.3) and has an area of 35% or more of the area of the larger wire. The fabric will be acceptable if the average of all weld shear test values across the specimen meets the prescribed minimum value.

24.7 Barbed Steel Wire (Galvanized)

24.7.1 Description

This Clause covers zinc-coated (galvanized) steel barbed wire, consisting of a strand of two wires 80 rods in length in a number of sizes and constructions, in accordance with ASTM A 121-86.

It is furnished in two grades (i.e. standard grade, chain-link fence grade) and with two classes (weights) of zinc coating (see 24.7.4).

The barbed wire shall be packaged on spools in lengths of 80 rods. The strands shall be twisted in one direction with a uniform length of lay.

The barbs shall be sharp, well formed and tightly wrapped.

24.7.2 Dimensions

24.7.2.1 Line wire

The size of zinc-coated wire shall be expressed in terms of the wire gage as shown in Table 98. The permissible variation from the nominal diameter of wire shall be ±0.13 mm.

24.7.2.2 Bars

The size of the zinc-coated wire used for the barbs shall be as described in Table 92. The permissible variation from the nominal diameter of the wire shall be ±0.13 mm. The barb length, measured from the center of the two strand wires, shall be 9.5 mm minimum.

24.7.2.3 Spacing of barbs

Barbs shall be spaced at a nominal 102 or 127 mm as shown in Table 92. The individual barb spacing shall be measured from the edge of one barb at the strand to the corresponding edge of the adjacent barb. Any sample, with 93.5% of the individual barb spacings conforming to the specified spacing ±19 mm and containing a minimum of 69 barbs (100 mm spacing), or 55 barbs (125 mm spacing) in 7.5 m, shall be considered acceptable. The length of barbed wire in each spool shall be 80 rods, 402 m minimum.

24.7.3 Properties

The breaking strength of the stranded barbed wire shall be in accordance with Table 93.

24.7.4 Weight of coating

The zinc-coated barbed wire shall conform to the requirements of Table 94 for minimum weight of zinc coating for the class ordered, namely:

a) Standard grade

For standard grade the requirements of Table 94 refer to the line wire only. The wire for barbs must have a minimum Class 1 coating weight.

b) Chain-link fence grade

For chain-link fence grade, both line wire and wire for barbs must have minimum Class 3 coating weight.

TABLE 92 - STANDARD SIZES AND CONSTRUCTION OF BARBED WIRE

SIZE, STEEL WIRE GAGE	NOMINAL DIAMETER OF ZINC-COATED WIRE IN STRAND mm	NUMBER OF POINTS	SPACING OF BARBS (mm)	DIAMETER OF BARBS, STEEL WIRE GAGE A)	SHAPE OF BARBS
12½	2.51	2	102	13 B)	Flat
12½	2.51	2	102	14	Round
12½	2.51	4	127	14	Round
12½	2.51	4	127	14 B)	Half-round
12½	2.51	2	127	14	Round
12½	2.51	2	102	12½ B)	Flat
13½	2.18	2	102	14	Round
13½	2.18	4	127	14	Round
15½	1.70	2	127	13¾ B)	Flat
15½	1.70	4	127	16½	Round

A) The nominal diameter of wire used in making barbs shall be as follows:

12½ gage 2.51 mm
13 gage 2.32 mm
13¾ gage 2.11 mm
14 gage 2.03 mm
16½ gage 1.47 mm

B) The gage of the half-round and flat barbs is designated by the gage of the round wire from which the barbs are rolled.

TABLE 93 - BREAKING STRENGTH OF ZINC-COATED STRAND

SIZE, STEEL WIRE GAGE	WIRE DIAMETER mm	MINIMUM STRAND BREAKING STRENGTH N
12½	2.51	4230
13½	2.18	4230
15½	1.70	4230

Note:

Breaking strength values reflect both wires tested together.

TABLE 94 - MINIMUM WEIGHT OF COATING ON ZINC-COATED BARBED WIRE

SIZE, STEEL WIRE GAGE	NOMINAL DIAMETER OF ZINC-COATED WIRE mm	MINIMUM WEIGHT OF COATING OF UNCOATED WIRE SURFACE (g/m²)	
		Class 1	Class 3
12½	2.51	90	245
13	2.32	75	200
13½	2.18	75	200
13¾	2.11		200
14	2.03	75	200
15½	1.70	A)	155
16½	1.74	A)	122

A) These sizes only furnished with Class 3 coating, chain link fence grade.

24.8 Seven-wire Steel Strand

24.8.1 Description

This Clause covers two grades of seven-wire uncoated stress-relieved steel strand for use in pretensioned and post-tensioned, prestressed concrete construction in accordance with ASTM A 416.

Grade 250: With minimum ultimate strengths of 1725 MPa (250.000 psi),
Grade 270: With minimum ultimate strengths of 1860 MPa (270.000 psi), respectively, based on the nominal area of strand.

24.8.2 Dimensions

24.8.2.1 The size of the finished strand shall be expressed as the nominal diameter of the strand in fractions Table 95.

24.8.2.2 The diameter of the center wire of any strand must be larger than the diameter of any outer wire in accordance with Table 97.

24.8.2.3 All grade 250 strand shall conform to a size tolerance of ±0.41 mm from the nominal diameter measured across the crowns of the wire.

24.8.2.4 All grade 270 strand shall conform to a size tolerance of +0.60, -0.15 mm from the nominal diameter measured across the crowns of the wire.

24.8.2.5 Variation in cross-sectional area and in unit stress resulting therefrom shall not be cause for rejection provided that the diameter differences of the individual wires and the diameters of the strand are within the tolerances specified.

24.8.3 Mechanical properties

24.8.3.1 Breaking strength

The breaking strength of the finished strand shall conform to the requirements prescribed in Table 95.

24.8.3.2 Yield strength

Yield strength in kN is measured at 1% extension under load. The load at this extension shall be recorded as yield strength and shall meet the requirements prescribed in Table 96.

24.8.3.3 Elongation

The total elongation under load shall not be less than 3.5%. In practice the total elongation value may be determined by adding to the 1.0% yield extension the percent extension or movement between the jaws gripping the strand after yield determination. The percent is calculated on the new base length of jaw-to-jaw distance.

TABLE 95 - BREAKING STRENGTH REQUIREMENTS

NOMINAL DIAMETER OF STRAND (mm)	BREAKING STRENGTH OF STRAND (kN)	NOMINAL STEEL AREA OF STRAND (mm^2)	NOMINAL WEIGHT OF STRANDS (kg/1000 m)
Grade 250			
6.35	40.0	23.22	182
7.94	64.5	37.42	294
9.53	89.0	51.61	405
11.11	120.1	69.98	548
12.70	160.1	92.90	730
15.24	240.2	139.35	1094
Grade 270			
9.53	102.3	54.84	432
11.11	137.9	74.19	582
12.70	183.7	98.71	775
15.24	260.7	140.00	1102

TABLE 96 - YIELD STRENGTH REQUIREMENTS A)

NOMINAL DIAMETER OF STRAND (mm)	INITIAL LOAD (kN)	MINIMUM LOAD AT 1% EXTENSION, (kN)
Grade 250		
6.35	4.0	34.0
7.94	6.5	54.7
9.53	8.9	75.6
11.11	12.0	102.3
12.70	16.0	136.2
15.24	24.0	204.2
Grade 270		
9.53	10.2	87.0
11.11	13.8	117.2
12.70	18.4	156.1
15.24	26.1	221.5

A) Minimum yield strength is 85% of specified minimum breaking strength.

TABLE 97 - DIAMETER RELATION BETWEEN CENTER AND OUTER WIRES

NOMINAL DIAMETER OF STRAND (mm)	MINIMUM DIFFERENCE BETWEEN CENTER WIRE DIAMETER AND DIAMETER OF ANY OUTER WIRE (mm)
Grade 250	
6.35 7.94 9.53 11.11 12.70 15.24	0.0254 0.0381 0.0508 0.0635 0.0762 0.1016
Grade 270	
9.53 11.11 12.70 15.24	0.0508 0.0635 0.0762 0.1016

24.9 Zinc-Coated Steel Chain-Link Fence Fabric

24.9.1 Description

This clause of the Standard specifies the requirements of zinc coated (galvanized) steel chain-link fence fabric, coated before or after weaving, in accordance with BS 4102.

24.9.2 Dimensions

24.9.2.1 Size of mesh

The size of mesh shall be as indicated in Table 98. The mesh size is the distance measured at right-angles internally between adjacent parallel wires and shall not exceed the tolerances shown in Table 99.

24.9.2.2 Size of wire

The nominal diameters of wires for chain-link fencing shall be as given in Table 100. Those used as tying wire or also as stirrup or line wire are given.

Two diameter measurements shall be made at right angles to each other at one cross-section. The average of the two measurements shall not differ from the nominal diameter, by more than the tolerances given in Table 99.

24.9.2.3 Nominal roll width (height)

Chain-link fabric shall be furnished in the nominal roll width shown in Table 104. The tolerance on the roll width shall be ± a quarter of the mesh pitch, the latter being the distance between two adjacent peaks on the same side of a single mesh wire.

24.9.3 Weight of zinc coating

Class 1: The weight of zinc coating shall not be less than 366 g/m² of uncoated wire surface (coated before weaving).

Class 2: The weight of zinc coating shall not be less than 610 g/m² of uncoated wire surface (coated before weaving).

Class 3: The weight of zinc coating shall not be less than 500 g/m² of uncoated wire surface (coated after weaving).

24.9.4 Tensile strength

Zinc coated wire shall be in the softened condition and the tensile strength shall be within the range 350 N/mm² to 550 N/mm².

TABLE 98 - CHAIN LINK FENCING MESH DIMENSIONS AND ROLL WIDTHS

MESH (mm)	NOMINAL WIRE DIAMETER (ZINC COATED) (mm)	NOMINAL ROLL WIDTH (m)							
		0.9	1.2	1.4	1.8	2.1	2.4	2.75	3.6
25	2.00	×	×	×	×				
40	2.00	×	×	×	×		×	×	
40	2.50	×	×	×	×		×	×	
40	3.50	×	×	×	×		×	×	
45	2.50							×	
50	2.00	×	×	×	×				
50	2.50	×	×	×	×		×	×	
50	3.00	×	×	×	×	×	×	×	×
50	3.55	×	×	×	×		×	×	
50	5.00			×	×		×	×	
75	2.50	×	×	×	×				
75	3.00	×	×	×	×				

TABLE 99 - TOLERANCES ON MESH SIZE AND DIAMETER OF WIRE

MESH SIZE (mm)	TOLERANCE (mm)	ZINC COATED DIAMETER	TOLERANCE (mm)
25	+2.0	Up to 2.36	0.05
40, 45, 50	+3.0	2.37 to 3.15	0.08
75	+4.0	3.16 to 5.00	0.10

TABLE 100 - NOMINAL DIAMETER OF WIRES FOR CHAIN LINK FENCING

ZINC COATED WIRE	mm	1.60 [1)]	2.00	2.50 [2)]	3.00	3.55	4.00	5.00

1) Diameter of tying wires.

2) Diameter of stirrup wires.

24.9.5 Weave and selvage

The wire shall be woven throughout in the form of approximately uniform square mesh, having parallel sides and horizontal and vertical diagonals of approximately uniform dimensions. Fabrics with 50 mm mesh, in height less than 1.8 m shall be knuckled at both selvages.

The selvages of fabric with meshes of less than 50 mm shall be knuckled.

Note:

Twisted selvages for fence fabric under 1.8 m in height are not recommended because of consumer safety consideration.

25. STRUCTURAL STEEL-ZINC COATED (GALVANIZED) PLATE SHEET AND STRIP

25.1 General

This Section specifies requirements for hot-dip zinc coated (hot-galvanized) flat rolled steel products, available in hot or cold roll conditions.

It covers plate, sheet and strip products, flat (see 25.2) or corrugated forms (see 25.3) as follows:

a) Sheet/plate

A flat rectangular product produced by cutting from strip and classified according to thickness as:

Sheet : thickness < 3 mm
Plate : thickness ≥ 3 mm

b) Strip

A flat rolled product that is wound into regular laps so as to form a coil. Hot or cold rolled wide strips are available as follows.

Wide strip : width ≥ 600 mm
Slit wide strip : from wide strip: width ≤ 600 mm

25.2 Flat Sheet, Plate and Strip (Zinc Coated)

25.2.1 Description

This Clause of the Standard specifies requirements for zinc coated (galvanized) flat rolled steel products including sheet, plate and strip, in accordance with BS 2989. The application of zinc coating consists of dipping suitable prepared objects in molten zinc. The zinc coating mass, including both sides, should be from minimum value of 100 g/m² of flat products up to 600 g/m² and more.

25.2.2 Dimensions

Nominal thickness, length and width of products shall be in accordance with Table 101.

25.2.3 Structural grades and chemical composition

The zinc coated flat rolled products shall have appropriate structural grade and chemical composition corresponding to minimum yield strength of products (see Table 102).

25.2.4 Mechanical properties

Mechanical properties of flat products shall be in accordance with Table 102.

TABLE 101 - DIMENSIONS OF FLAT SHEET, PLATE AND STRIP (INCLUDING COATING ON BOTH SIDES)

NOMINAL THICKNESS mm	NOMINAL LENGTH FOR ALL THICKNESSES (mm)	NOMINAL WIDTH FOR ALL THICKNESSES (mm)
> 0.35 to ≤ 0.40 > 0.40 to ≤ 0.60 > 0.60 to ≤ 0.80 > 0.80 to ≤ 1.00 > 1.00 to ≤ 1.20 > 1.20 to ≤ 1.60 > 1.60 to ≤ 2.00 > 2.00 to ≤ 2.50 > 2.50 to ≤ 3.00 > 3.00 to ≤ 4.00 > 4.00 to ≤ 5.00	< 1500 ≥ 1500 to ≤ 3000 > 3000	≤ 1200 > 1200 to ≤ 1500

TABLE 102 - MECHANICAL PROPERTIES AND CHEMICAL COMPOSITIONS

STRUCTURAL GRADE	MINIMUM YIELD STRENGTH N/mm²	MINIMUM TENSILE STRENGTH N/mm²	MINIMUM ELONGATION AFTER FRACTURE (L = 50 mm) %	CHEMICAL COMPOSITION % Max.		
				C	Mn	S
Z 22	220	(290)	20	0.15	0.60	0.040
Z 25	250	(350)	19	0.16	0.60	0.040
Z 28	280	(390)	18	0.20	0.80	0.040
Z 35	350	(450)	15	0.25	1.50	0.040
Z 55	550	(560)	—	0.16	0.60	0.040

Note:

Figures in brackets are non-mandatory and are for information only.

25.3 Corrugated Steel Sheet (Zinc Coated)

25.3.1 Description

This clause of the Standard specifies requirements for materials, dimensions and properties of hot-dip zinc coated (hot galvanized) corrugated steel sheets in accordance with BS 3083:1988.

The zinc coating mass, including both sides should be from minimum value of 350 g/m² of corrugated sheet up to 6000 g/m² and more.

25.3.2 Dimensions

25.3.2.1 Nominal coated thickness and length of sheets shall be in accordance with Table 103 and width in accordance with Table 104.

25.3.2.2 Sheets shall posses the profiles and have the nominal cover widths shown in Fig. 7 and Table 104. The tolerance on the 19 mm depth of corrugation shall be +0, -3 mm.

25.3.2.3 Table 105 determines the nominal mass for any particular length of sheet, or the length for any particular mass of sheets.

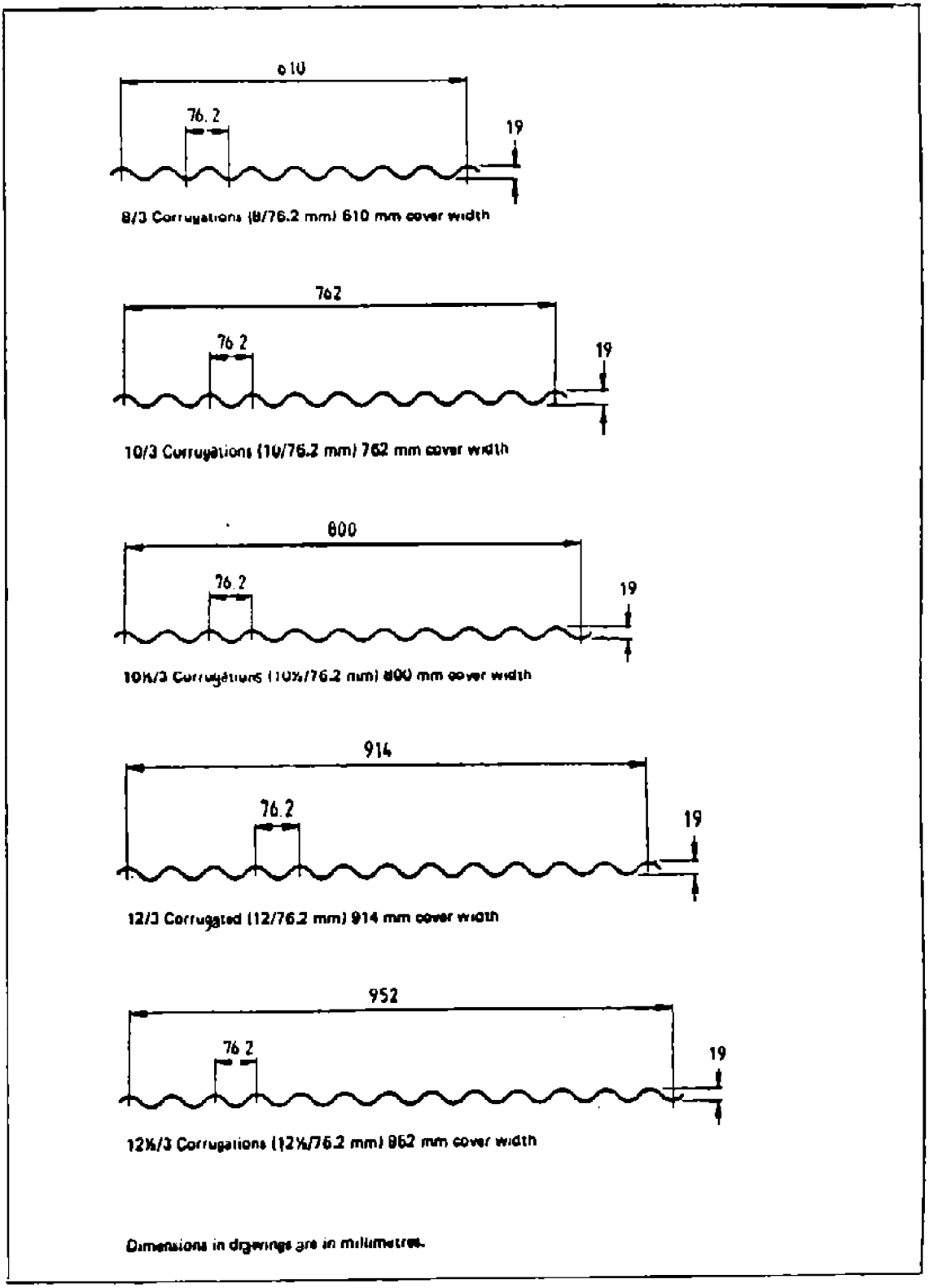
TABLE 103 - THICKNESS AND LENGTH OF CORRUGATED SHEETS (INCLUDING ZINC COATING ON BOTH SIDES)

NOMINAL THICKNESS mm	NOMINAL LENGTH AND TOLERANCES FOR ALL THICKNESSES
≤ 0.6 > 0.6 to ≤ 0.8 > 0.8 to ≤ 1.0 > 1.0 to ≤ 1.2 > 1.2 to ≤ 1.6 > 1.6 to ≤ 2.0	≤ 3000 $^{-0}_{+8}$ mm > 3000 $^{-0}_{+0.3\%}$

TABLE 104 - WIDTH

DESCRIPTION	WIDTH
Sheet before corrugating*	mm
8/3 corrugations	743
10/3 corrugations	908
10½/3 corrugations	946
12/3 corrugations	1070
12½/3 corrugations	1113
Sheets after corrugating (distance between the crowns of the outside corrugations)	
8/3 corrugations	610 ±5
10/3 corrugations	762 ±5
10½/3 corrugations	800 ±6
12/3 corrugations	914 ±6
12½/3 corrugations	952 ±6

*** Not always applicable to sheets for curving.**



PROFILE AND COVER WIDTH
Fig. 7

TABLE 105 - NOMINAL MASS PER METER RUN (AND LENGTH PER MASS) FOR HOT-DIP ZINC COATED PRODUCTS

THICKNESS	8/3 (743 mm)		10/3 (908 mm)		10½/3 (946 mm)		12/3 (1070 mm)		12½/3 (1130 mm)	
mm	kg/m	m/t	kg/m	m/t	kg/m	m/t	kg/m	m/t	kg/m	m/t
0.40	2.50	400	3.05	328	3.18	315	3.59	278	3.80	263
0.50	2.94	341	3.59	279	3.74	267	4.23	236	4.47	224
0.60	3.52	284	4.31	232	4.49	223	5.07	197	5.36	187
0.70	4.11	243	5.02	199	5.23	191	5.92	169	6.25	160
0.80	4.70	213	5.74	178	5.89	167	6.77	148	7.15	140
0.90	5.28	192	6.45	156	6.73	151	7.61	133	8.04	126
1.00	5.87	170	7.17	139	7.48	134	8.46	118	8.93	112
1.20	7.05	142	8.61	116	8.97	111	10.15	99	10.27	93
1.60	9.40	106	11.48	87	11.96	84	13.53	74	14.29	70
2.00	11.75	85	14.35	70	14.95	67	16.92	59	17.87	56

26. STRUCTURAL STEEL-HOT ROLLED I-BEAMS

26.1 General

This Section of the Standard specifies the dimensions, tolerances and certain properties of the following hot rolled I-beams:

- Medium flange I-beams (IPE) (26.2).
- Wide flange, light weight I-beams (IPBl) (26.3).
- Wide flange, medium weight I-beams (IPB) (26.4).
- Wide flange, heavy weight I-beams (IPBv) (26.5).
- Sloping flange beams and column sections (narrow flange and wide flange) (26.6).
- Castellated beams (26.7).

26.2 Medium Flange I-beams (IPE)

26.2.1 Description

26.2.1.1 This Clause of the Standard specifies dimensions, and sectional properties and tolerances of hot-rolled steel, medium flange I-beams (IPE series) in accordance with ISIRI 1791 (DIN 1025, Part 5).

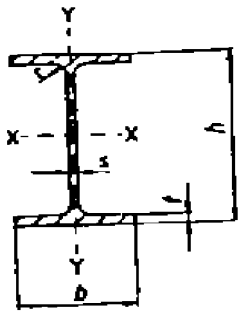
26.2.2 Dimensions and mass

Dimensions and mass of medium flange I-beams shall be in accordance with Table 106 (see Fig. 8).

Tolerances of dimensions shall be in accordance with ISIRI 1791.

26.2.3 Properties

Chemical analysis and mechanical properties shall in accordance with ISIRI 1600.



MEDIUM FLANGE I-BEAMS
Fig. 8

TABLE 106 - DIMENSIONS AND WEIGHT FOR I-BEAMS (IPE SERIES)

SECTION SYMBOL IPE	DIMENSIONS FOR					SECTION AREA, F, IN cm²	WEIGHT G, IN kg/m
	h	b	s	t	r		
80	80	46	3.8	5.2	5	7.64	6.0
100	100	55	4.1	5.7	7	10.3	8.1
120	120	64	4.4	6.3	7	13.2	10.4
140	140	73	4.7	6.9	7	16.4	12.9
160	160	82	5.0	7.4	9	20.1	15.8
180	180	91	5.3	8.0	9	23.9	18.8
200	200	100	5.6	8.5	12	28.5	22.4
220	220	110	5.9	9.2	12	33.4	26.2
240	240	120	6.2	9.8	15	39.1	30.7
270	270	135	6.6	10.2	15	45.9	36.1
300	300	150	7.1	10.7	15	53.8	42.2
330	330	160	7.5	11.5	18	62.6	49.1
360	360	170	8.0	12.7	18	72.7	57.1
400	400	180	8.6	13.5	21	84.5	66.3
450	450	190	9.4	14.6	21	98.8	77.6
500	500	200	10.2	16.0	21	116	90.7
550	550	210	11.1	17.2	24	134	106
600	600	220	12.0	19.0	24	156	122

26.3 Wide Flange Light Weight I-beams (IPBl)

26.3.1 Description

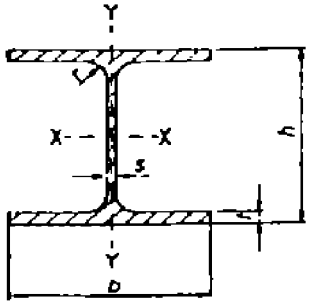
This Clause of the Standard specifies dimensions, sectional properties and tolerances of hot-rolled steel wide flange light-weight I-beams in accordance with DIN. 1025, Part 3.

26.3.2 Dimensions and masses

- Dimensions and masses of IPBl shall be in accordance with Table 107 (see Fig. 9).
- Tolerance of dimensions shall be in accordance with DIN 10034.

26.3.3 Properties

Chemical analysis and mechanical properties shall be in accordance with ISIRI 1600.



WIDE FLANGE, LIGHT-WEIGHT I-BEAMS
Fig. 9

TABLE 107 - DIMENSIONS AND WEIGHT FOR I - SECTIONS (IPBI SERIES)

SECTION SYMBOL IPE	DIMENSIONS FOR					SECTION AREA, F, IN cm²	WEIGHT G, IN kg/m
	h	b	s	t	r		
100	96	100	5	8	12	21.2	16.7
120	114	120	5	8	12	25.3	19.9
140	133	140	5.5	8.5	12	31.4	24.7
160	152	160	6	9	15	38.8	30.4
180	171	180	6	9.5	15	45.3	35.5
200	190	200	6.5	10	18	53.8	42.3
220	210	220	7	11	18	64.3	50.5
240	230	240	7.5	12	21	76.8	60.3
260	250	260	7.5	12.5	24	86.8	68.2
280	270	280	8	13	24	97.3	76.4
300	290	300	8.5	14	27	112	88.3
320	310	300	9	15.5	27	124	97.6
340	330	300	9.5	16.5	27	133	105
360	350	300	10	17.5	27	143	112
400	390	300	11	19	27	159	125
450	440	300	11.5	21	27	178	140
500	490	300	12	23	27	198	155
550	540	300	12.5	24	27	212	166
600	590	300	13	25	27	226	178
650	640	300	13.5	26	27	242	190
700	690	300	14.5	27	27	260	204
800	790	300	15	28	30	286	224
900	890	300	16	30	30	320	252
1000	990	300	16.5	31	30	347	272

26.4 Wide Flange Medium Weight I-beams (IPB)

26.4.1 Description

This Clause of the Standard specifies dimensions, and sectional properties and tolerances of hot-rolled steel, medium flange I-beams in accordance with DIN 1025 Part 2.

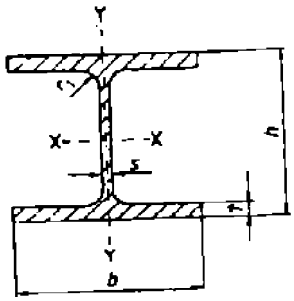
26.4.2 Dimensions and masses

Dimensions and masses of IPB sections shall be in accordance with Table 108 (see Fig. 10).

Tolerance of dimensions shall be in accordance with DIN 10034.

26.4.3 Properties

Chemical analysis and mechanical properties of IPB shall be in accordance with ISIRI 1600.



WIDE FLANGE MEDIUM WEIGHT I-BEAMS
Fig. 10

TABLE 108 - DIMENSIONS AND WEIGHT FOR I-SECTIONS WITH PARALLEL FLANGE (IPB SERIES)

SECTION SYMBOL IPE	DIMENSIONS FOR					SECTION AREA, F, IN cm²	WEIGHT G, IN kg/m
	h	b	s	t	r		
100	100	100	6	10	12	26.0	20.4
120	120	120	6.5	11	12	34.0	26.7
140	140	140	7	12	12	43.0	33.7
160	160	160	8	13	15	54.3	42.6
180	180	180	8.5	14	15	65.3	51.2
200	200	200	9	15	18	78.1	61.3
220	220	220	9.5	16	18	91.0	71.5
240	240	240	10	17	21	106	83.2
260	260	260	10	17.5	24	118	93.0
280	280	280	10.5	18	24	131	103
300	300	300	11	19	27	149	117
320	320	300	11.5	20.5	27	161	127
340	340	300	12	21.5	27	171	134
360	360	300	12.5	22.5	27	181	142
400	400	300	13.5	24	27	198	155
450	450	300	14	26	27	218	171
500	500	300	14.5	28	27	239	187
550	550	300	15	29	27	254	199
600	600	300	15.5	30	27	270	212
650	650	300	16	31	27	286	225
700	700	300	17	32	27	306	241
800	800	300	17.5	33	30	334	262
900	900	300	18.5	35	30	371	291
1000	1000	300	19	36	30	400	314

26.5 Wide Flange Heavy Weight I-Beams (IPBv)

26.5.1 Description

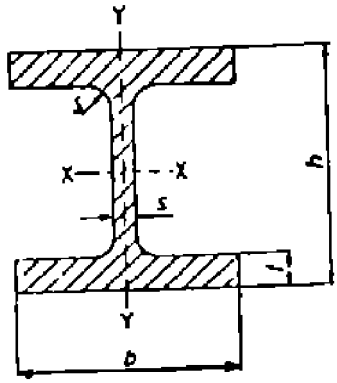
This Clause of the Standard specifies dimensions, sectional properties and tolerances of hot-rolled steel wide flange, heavy weight I-beams in accordance with DIN 1025, Part 4.

26.5.2 Dimensions and masses

Dimensions and masses of H sections (IPBv series) shall be in accordance with Table 109 (see Fig. 11).

Tolerances of dimensions of IPBv shall be in accordance with DIN 10034.

26.5.3 Chemical and mechanical properties shall be in accordance with ISIRI 1600.



WIDE FLANGE HEAVY WEIGHT I-BEAMS
Fig. 11

TABLE 109 - DIMENSIONS AND WEIGHT FOR I-SECTIONS (IPBv SERIES)

SECTION SYMBOL IPE	DIMENSIONS FOR					SECTION AREA, F, IN cm²	WEIGHT G, IN kg/m
	h	b	s	t	r		
100	120	106	12	20	12	53.2	41.8
120	140	126	12.5	21	12	66.4	52.1
140	160	146	13	22	12	80.6	63.2
160	180	166	14	23	15	97.1	76.2
180	200	186	14.5	24	15	113	88.9
200	220	206	15	25	18	131	103
220	240	226	15.5	26	18	149	117
240	270	248	18	32	21	200	157
260	290	268	18	32.5	24	220	172
280	310	288	18.5	33	24	240	189
300	340	310	21	39	27	303	238
320/305	320	305	16	29	27	225	177
320	359	309	21	40	27	312	245
340	377	309	21	40	27	316	248
360	395	308	21	40	27	319	250
400	432	307	21	40	27	326	256
450	478	307	21	40	27	335	263
500	524	306	21	40	27	344	270
550	572	306	21	40	27	354	278
600	620	305	21	40	27	364	285
650	668	305	21	40	27	374	293
700	716	304	21	40	27	383	301
800	814	303	21	40	30	404	317
900	910	302	21	40	30	424	333
1000	1008	302	21	40	30	444	349

26.6 Sloping Flange Beams and Column Sections

26.6.1 Description

This Clause of the Standard specifies dimensions and sectional properties and tolerances of following hot rolled sections:

a) Sloping flange beam sections (narrow flange).
b) Sloping flange column sections (wide flange).

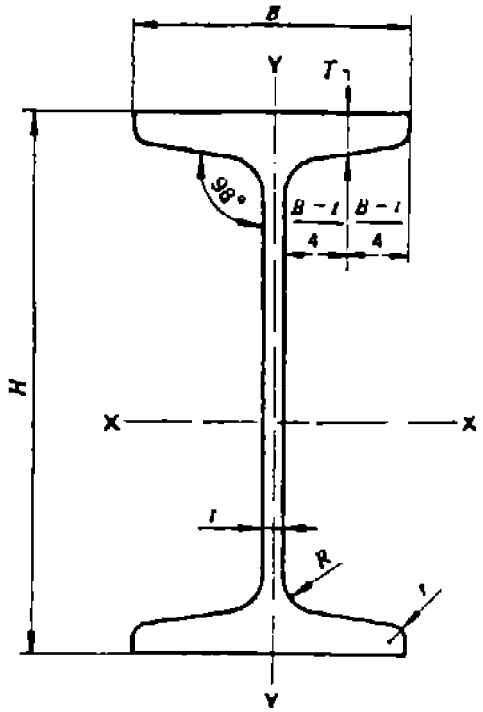
26.6.2 Dimensions and masses

26.6.2.1 Dimensions and masses of sloping, narrow flange beam sections shall be in accordance with ISO 657/15 (see Fig. 12 and Table 110) and tolerances in dimensions shall be in accordance with ISO 657/13.

26.6.2.2 Dimensions and masses of sloping, wide flange column sections shall be in accordance with ISO 657/16 (see Fig. 13 and Table 111) and tolerances in dimensions shall be in accordance with ISO 657/13.

26.6.3 Properties

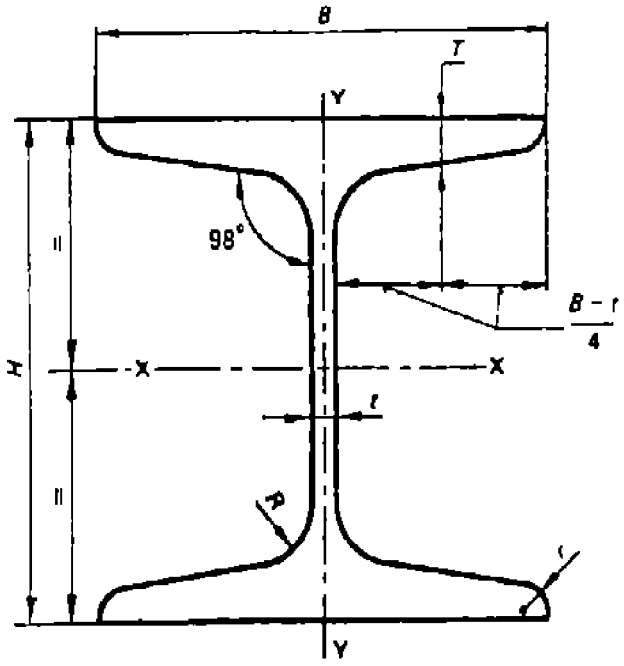
Chemical analysis and mechanical properties of sloping flange beams and column sections shall be in accordance with ISIRI 1600.



STEEL SLOPING, NARROW FLANGE BEAM SECTION
Fig. 12

TABLE 110 - DIMENSIONS AND MASS OF HOT-ROLLED STEEL SLOPING FLANGE BEAM SECTIONS

DESIGNATION	MASS M kg/m	SECTIONAL AREA A cm²	DIMENSIONS					
			H mm	B mm	T mm	t mm	R mm	r mm
SB 80 × 6	6.03	7.69	80	40	6.0	4.0	6.0	3.0
SB 100 × 8	8.57	10.9	100	50	6.8	4.5	7.0	3.5
SB 120 × 12	11.5	14.7	120	60	7.6	5.0	8.0	4.0
SB 140 × 15	14.8	18.8	140	70	8.4	5.5	8.0	4.0
SB 160 × 18	18.5	23.6	160	80	9.2	6.0	9.0	4.5
SB 180 × 23	22.7	28.9	180	90	10.0	6.5	10.0	5.0
SB 200 × 27	27.2	34.6	200	100	10.8	7.0	11.0	5.5
SB 220 × 32	32.1	40.8	220	110	11.6	7.5	11.0	5.5
SB 240 × 36	36.4	46.3	240	120	12.0	7.8	12.0	6.0
SB 250 × 38	38.4	49.0	250	125	12.2	7.9	12.0	6.0
SB 270 × 41	41.3	52.6	270	125	12.7	8.2	13.0	6.5
SB 300 × 46	45.8	58.4	300	130	13.2	8.5	13.0	6.5
SB 350 × 56	58.8	71.1	350	140	14.6	9.1	15.0	7.5
SB 400 × 66	65.5	83.5	400	150	15.5	9.7	16.0	8.0
SB 450 × 76	76.1	96.9	450	160	16.5	10.3	16.0	8.0
SB 500 × 91	91.2	116.0	500	170	18.7	11.0	19.0	9.5
SB 550 × 107	107	136.0	550	180	20.4	12.0	20.0	10.0
SB 600 × 131	131	167.0	600	210	22.1	13.0	22.0	11.0



SLOPING WIDE FLANGE COLUMN SECTION
Fig. 13

TABLE 111 - DIMENSIONS & MASS OF SLOPING WIDE FLANGE COLUMN SECTIONS

DESIGNATION	MASS M kg/m	SECTIONAL AREA A cm²	DIMENSIONS					
			H mm	B mm	t mm	T mm	R mm	r mm
SC 100	20.0	25.5	100	100	6.0	10	12	6.0
SC 120	26.2	33.4	120	120	6.5	11	12	6.0
SC 140	33.3	42.4	140	140	7.0	12	12	6.0
SC 160	41.9	53.4	160	160	8.0	13	15	7.5
SC 180	50.5	64.4	180	180	8.5	14	15	7.5
SC 200	60.3	76.8	200	200	9.0	15	18	9.0
SC 220	70.4	89.8	220	220	9.5	16	18	9.0
SC 250	85.6	109	250	250	10.0	17	23	11.5

26.7 Castellated Beams

26.7.1 Description

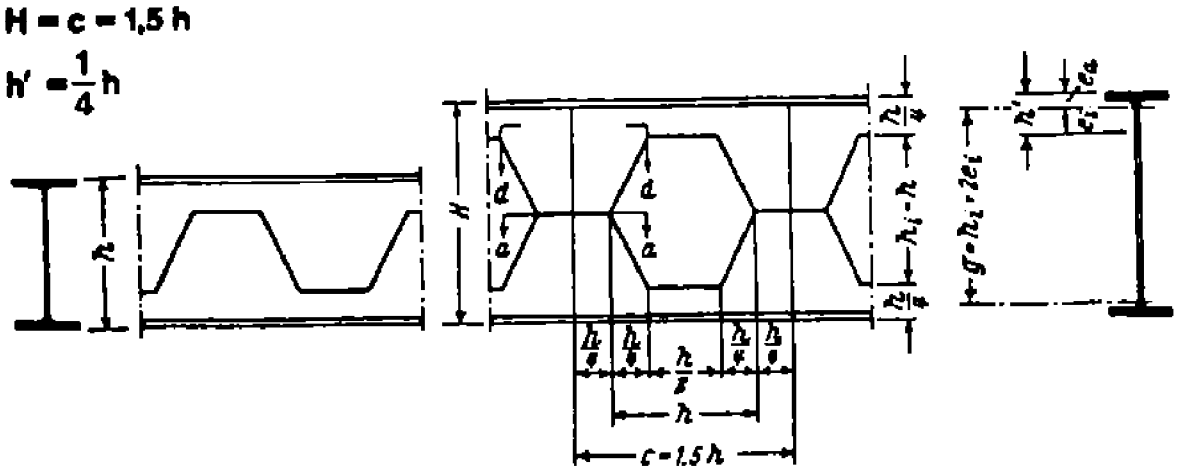
This Clause of the Standard specifies the dimensions, sectional properties and tolerances of castellated beams from IPB in accordance with DIN 1025.

26.7.2 Dimensions

Dimensions of castellated beams shall be in accordance with Table 112 (Fig. 14). Tolerances of dimensions shall be tolerances of original I-beams.

26.7.3 Properties

Chemical and mechanical properties shall be in accordance with properties of original I-beams.



CASTELLATED BEAM
Fig. 14

TABLE 112 - CASTELLATED BEAMS

TABLE 112 - a) CASTELLATED BEAM FROM MEDIUM FLANGE I-BEAM (IPE)

ROLLED CASTELLATED BEAM	h mm	H mm	e_a mm	e_i mm	g mm
IPE 180	180	270	8.8	36.2	252
IPE 200	200	300	9.7	40.3	281
IPE 220	220	330	10.5	44.5	309
IPE 240	240	360	11.3	48.7	337
IPE 270	270	405	12.4	55.1	380
IPE 300	300	450	13.7	61.3	423
IPE 330	330	495	15	67.5	465
IPE 360	360	540	16.4	73.6	507
IPE 400	400	600	18.5	81.5	563
IPE 450	450	675	21.2	91.3	633
IPE 500	500	750	24	101	702
IPE 550	550	825	26.9	111	771
IPE 600	600	900	29.8	120	840

TABLE 112 - b) CASTELLATED BEAM FROM WIDE FLANGE MEDIUM WEIGHT I-BEAM (IPB)

ROLLED CASTELLATED BEAM	h mm	H mm	e_a mm	e_i mm	g mm
IPB 180	180	270	9.4	35.6	251
IPB 200	200	300	10.2	39.8	279
IPB 220	220	330	10.9	44.1	308
IPB 240	240	360	11.8	48.2	336
IPB 260	260	390	12.3	52.7	365
IPB 280	280	420	12.9	57.1	394
IPB 300	300	450	13.7	61.3	423
IPB 320	320	480	14.8	65.2	450
IPB 340	340	510	15.8	69.2	478
IPB 360	360	540	16.7	73.3	506
IPB 400	400	600	18.7	81.3	563
IPB 450	450	675	20.9	91.6	633
IPB 500	500	750	23.3	102	703
IPB 550	550	825	25.6	112	774
IPB 600	600	900	28.1	122	844
IPB 650	650	975	30.7	132	914
IPB 700	700	1050	33.8	141	982
IPB 800	800	1200	39.3	161	1121
IPB 900	900	1350	45.6	179	1259
IPB 1000	1000	1500	51.9	198	1396

TABLE 112 - c) CASTELLATED BEAM FROM WIDE FLANGE LIGHT WEIGHT I-BEAM (IPB1)

ROLLED CASTELLATED BEAM	h mm	H mm	e_a mm	e_i mm	g mm
IPB 180	171	256	7.3	35.5	242
IPB 200	190	285	8	39.5	269
IPB 220	210	315	8.6	43.9	298
IPB 240	230	345	9.5	48	326
IPB 260	250	375	10	52.5	355
IPB 280	270	405	10.6	56.9	384
IPB 300	290	435	11.4	61.1	412
IPB 320	310	465	12.4	65.1	440
IPB 340	330	495	13.4	69.1	468
IPB 360	350	525	14.4	73.1	496
IPB 400	390	585	16.3	81.2	552
IPB 450	440	660	18.5	91.5	623
IPB 500	490	735	20.9	102	693
IPB 550	540	810	23.2	112	764
IPB 600	590	885	25.6	122	834
IPB 650	640	960	28.2	132	904
IPB 700	690	1035	31.4	141	972
IPB 800	790	1185	36.9	161	1111
IPB 900	890	1335	43.2	179	1249
IPB 1000	990	1485	49.5	198	1386

TABLE 112 - d) CASTELLATED BEAM FROM WIDE FLANGE LIGHT WEIGHT I-BEAM (IPBv)

ROLLED CASTELLATED BEAM	h mm	H mm	e_a mm	e_i mm	g mm
IPB 180	200	300	14.2	35.8	272
IPB 200	220	330	15.1	39.9	300
IPB 220	240	360	15.8	44.2	328
IPB 240	270	405	18.9	48.6	367
IPB 260	290	435	19.5	53	396
IPB 280	310	465	20	57.5	425
IPB 300	340	510	23.2	61.8	464
IPB 320	359	538	24	65.7	490
IPB 340	377	565	24.5	69.8	516
IPB 360	395	592	25	73.8	542
IPB 400	432	648	26.1	81.9	596
IPB 450	478	717	27.6	91.9	662
IPB 500	524	786	29.2	102	728
IPB 550	572	858	31.1	112	796
IPB 600	620	930	33.1	122	864
IPB 650	668	1002	35.2	132	932
IPB 700	716	1074	37.5	141	999
IPB 800	814	1221	42.6	161	1136
IPB 900	910	1365	47.9	180	1269
IPB 1000	1008	1512	53.8	198	1404

27. STRUCTURAL STEEL-CHANNEL SECTIONS

27.1 Description

This Clause of the Standard specifies dimensions and mass of hot-rolled steel, sloping flange, channel sections in accordance with ISO 657/11-1980.

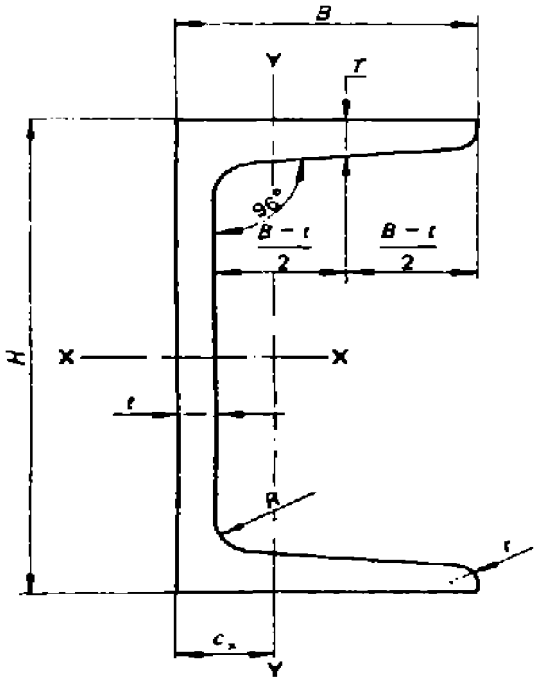
27.2 Dimensions

Dimensions of sloping flange channel section shall be in accordance with Table 113 (Fig. 15).

Tolerances in dimension shall be in accordance with ISO 657/13.

27.3 Properties

Chemical analysis and mechanical properties of channel sections shall be in accordance with ISIRI 1600.



SLOPING FLANGE CHANNEL SECTION
Fig. 15

TABLE 113 - DIMENSIONS AND MASS OF SLOPING FLANGE CHANNEL SECTIONS

DESIGNATION	MASS M kg/m	SECTIONAL AREA A cm²	DIMENSIONS					
			H mm	B mm	T mm	t mm	R mm	r mm
CH 80 × 8	8.23	10.5	80	45	7.5	5.5	8.0	4.0
CH 100 × 10	10.3	13.1	100	50	8.0	5.9	8.0	4.5
CH 120 × 12	12.5	16.0	120	55	8.5	6.3	8.0	4.5
CH 140 × 15	15.0	19.2	140	60	9.0	6.7	9.0	4.5
CH 160 × 18	18.2	23.2	160	65	10.0	7.2	9.0	5.5
CH 180 × 21	21.3	27.2	180	70	10.5	7.7	10.0	5.5
CH 200 × 25	25.2	32.1	200	75	11.5	8.2	12.0	6.0
CH 220 × 29	28.7	36.6	220	80	12.0	8.7	12.0	6.5
CH 250 × 34	33.9	43.2	250	85	13.0	9.2	13.5	7.0
CH 300 × 45	45.2	57.5	300	100	15.0	10.0	15.0	8.0
CH 350 × 52	51.8	66.0	350	100	16.0	10.5	16.0	8.0
CH 400 × 59	58.9	75.0	400	100	17.0	11.0	17.0	8.5

28. STRUCTURAL STEEL-TEE SECTIONS

28.1 Description

This Clause specifies dimensions of round edge, hot rolled T-sections with equal depth and flange width in accordance with DIN 1024 (ISO 657/21).

This Clause does not apply to hot rolled T-section with square edges (see DIN 59051).

28.2 Dimensions

The dimensions weights and cross-sectional areas of the I-Sections are given in Table 114 and Figs. 16 and 17. It also contains the permissible variation in dimensions.

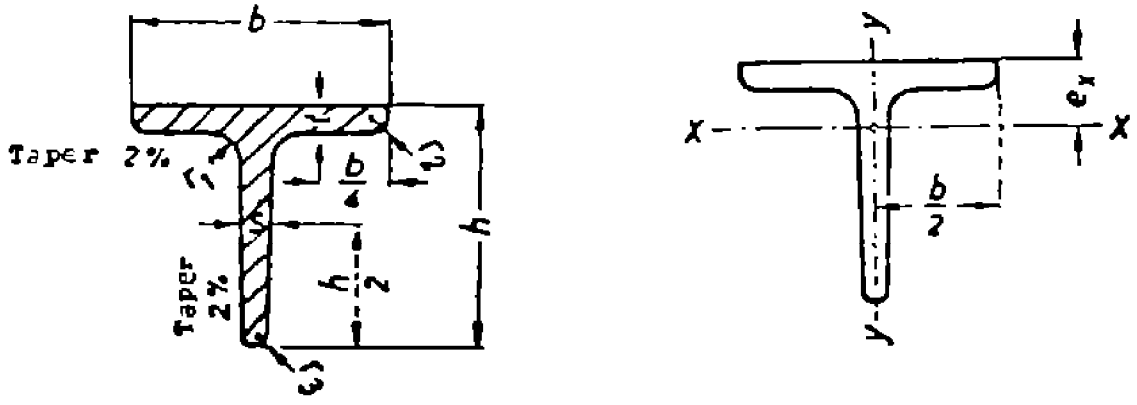
28.3 Properties

Chemical analysis and mechanical properties of T-Sections shall be in accordance with ISIRI 1600.

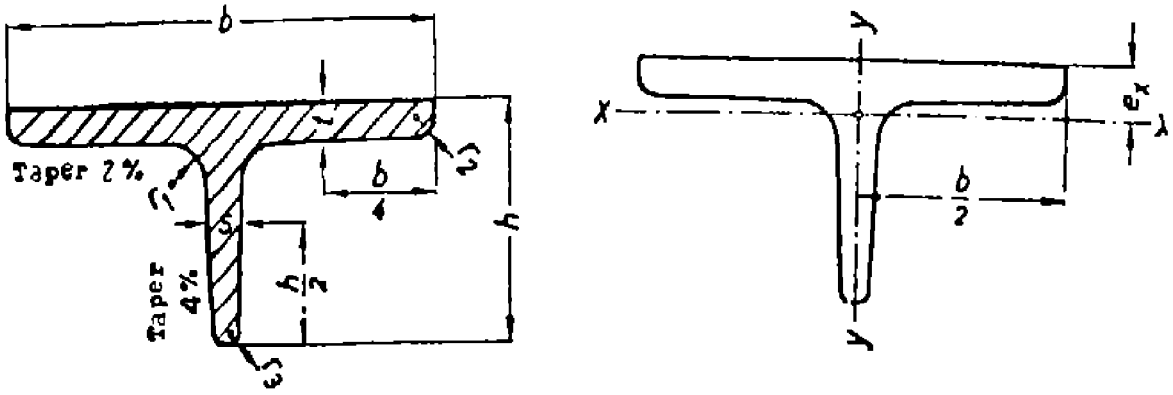
TABLE 114 - DIMENSIONS AND WEIGHTS OF T-SECTIONS

SYMBOL	DIMENSIONS FOR						Cross sectional area F cm²	Weigh G (1) kg/m
	h Perm. var.	b Perm. var.	s=t Perm. var.	r_1	r_2	r_3		
Round edge deep web T-bar								
T 20	20 ±1.0	20 ±1.0	3 ±0.5	3	1.5	1	1.12	0.88
T 25	25 ±1.0	25 ±1.0	3.5 ±0.5	3.5	2	1	1.64	1.29
T 30	30 ±1.0	30 ±1.0	4 ±0.5	4	2	1	2.26	1.77
T 35	35 ±1.0	35 ±1.0	4.5 ±0.5	4.5	2.5	1	2.97	2.33
T 40	40 ±1.0	40 ±1.0	5 ±0.5	5	2.5	1	3.77	2.96
T 45	45 ±1.0	45 ±1.0	5.5 ±0.5	5.5	3	1.5	4.67	3.67
T 50	50 ±1.0	50 ±1.0	6 ±0.5	6	3	1.5	5.66	4.44
T 60	60 ±1.5	60 ±1.5	7 ±0.75	7	3.5	2	7.94	6.23
T 70	70 ±1.5	70 ±1.5	8 ±0.75	8	4	2	10.6	8.32
T 80	80 ±1.5	80 ±1.5	9 ±0.75	9	4.5	2	13.6	10.7
T 90	90 ±1.5	90 ±1.5	10 ±0.75	10	5	2.5	17.1	13.4
T 100	100 ±1.5	100 ±1.5	11 ±0.75	11	5.5	3	20.9	16.4
T 120	120 ±2.0	120 ±2.0	13 ±1.0	13	6.5	3	29.6	23.2
T 140	140 ±2.0	140 ±2.0	15 ±1.0	15	7.5	4	39.9	31.3
Round edge wide flange T-bar								
TB 30	30 ±1.0	60 ±1.5	5.5 ±0.75	5.5	3	1.5	4.64	3.64
TB 35	35 ±1.0	70 ±1.5	6 ±0.75	6	3	1.5	5.94	4.66
TB 40	40 ±1.0	80 ±1.5	7 ±0.75	7	3.5	2	7.91	6.21
TB 50	50 ±1.0	100 ±1.5	8.5 ±0.75	8.5	4.5	2	12.0	9.42
TB 60	60 ±1.5	120 ±2.0	10 ±0.1	10	5	2.5	17.0	13.5

(1) The weights have been evaluated from the cross-section on the basis of a density of 7.85 kg/dm³.



ROUND EDGE DEEP WEB T-BAR (T)
Fig. 16



ROUND EDGE WIDE FLANGE T-BAR (TB)
Fig. 17

29. STRUCTURAL STEEL-ANGLE SECTIONS

29.1 Equal-leg Angles

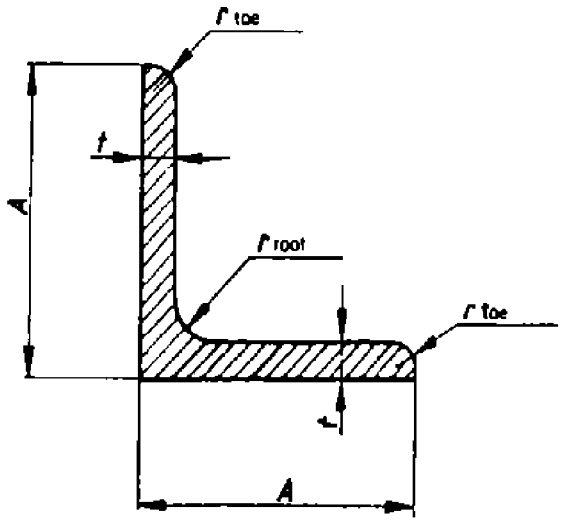
29.1.1 Description

This Clause of the Standard specifies the dimensions, mass, tolerances and sectional areas of steel equal-leg angles in accordance with ISO 657-1.

29.1.2 The dimensions, mass and sectional areas of the equal leg angles are given in Table 115 and Fig. 18.

29.1.3 The tolerances on the dimensions shall be in accordance with ISIRI 1792 (ISO 657-5).

29.1.4 The chemical composition and mechanical properties shall be in accordance with ISIRI 1600.



EQUAL LEG ANGLE
Fig. 18

TABLE 115 - DIMENSIONS, WEIGHT AND SECTIONAL AREAS OF HOT-ROLLED EQUAL-LEG ANGLES

DESIGNATION (1)	WEIGHT [1] kg/m (2)	SECTIONAL AREA cm² (3)	DIMENSIONS		
			A mm (4)	t mm (5)	r root mm (6)
20 × 20 × 3	0.882	1.12	20	3	3.5
25 × 25 × 3	1.12	1.42	25	3	3.5
25 × 25 × 4	1.45	1.85	25	4	3.5
30 × 30 × 3	1.36	1.74	30	3	5
30 × 30 × 4	1.78	2.27	30	4	5
40 × 40 × 4	2.42	3.08	40	4	6
40 × 40 × 5	2.97	3.79	40	5	6
50 × 50 × 5	3.77	4.80	50	5	7
50 × 50 × 6	4.47	5.69	50	6	7
60 × 60 × 5	4.57	5.82	60	5	8
60 × 60 × 6	5.42	6.91	60	6	8
65 × 65 × 8	7.73	9.85	65	8	9
70 × 70 × 6	6.38	8.13	70	6	9
70 × 70 × 7	7.38	9.40	70	7	9
80 × 80 × 6	7.34	9.35	80	6	10
80 × 80 × 8	9.63	12.3	80	8	10
90 × 90 × 8	10.9	13.9	90	8	11
90 × 90 × 10	15.0	17.1	90	10	11
100 × 100 × 8	12.2	15.5	100	8	12
100 × 100 × 10	15.0	19.2	100	10	12
120 × 120 × 10	18.2	23.2	120	10	13
120 × 120 × 12	21.6	27.5	120	12	13
150 × 150 × 12	27.3	34.8	150	12	16
150 × 150 × 12	33.8	43.0	150	15	16
200 × 200 × 16	48.5	61.8	200	16	18
200 × 200 × 20	59.9	76.3	200	20	18

1) Weight is calculated on the basis of density of steel of 7.85 kg/dm³.

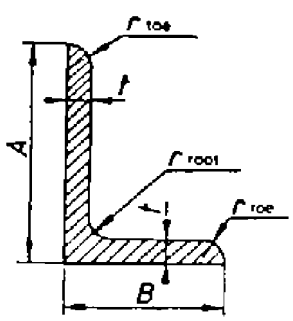
29.2 UNEQUAL-LEG ANGLES

29.2.1 This Clause of the Standard specifies the dimensions, tolerances and sectional properties of steel unequal-leg angles in accordance with ISO 657-2.

29.2.2 The dimensions, mass and sectional areas of the unequal-leg angles are given in Table 116 and Fig. 19.

29.2.3 The tolerances on the dimensions shall meet the requirements prescribed in ISIRI 1792 (ISO 657-5).

29.2.4 The chemical composition and mechanical properties shall be in accordance with ISIRI 1600.



UNEQUAL LEG ANGLES
Fig. 19

TABLE 116 - DIMENSIONS WEIGHT AND SECTIONAL AREAS OF HOT ROLLED UNEQUAL-LEG ANGLES

DESIGNATION	WEIGHT [1] kg/m	SECTIONAL AREA cm²	DIMENSIONS			
			A mm	B mm	t mm	r root mm
30 × 20 × 3	1.12	1.43	30	20	3	4
30 × 20 × 4	1.46	1.86	30	20	4	4
40 × 20 × 4	1.77	2.26	40	20	4	4
40 × 25 × 4	1.93	2.46	40	25	4	4
45 × 30 × 5	2.76	3.52	45	30	5	4
50 × 30 × 5	2.96	3.78	50	30	5	5
60 × 30 × 5	3.36	4.28	60	30	5	5
60 × 40 × 5	3.76	4.79	60	40	5	6
65 × 50 × 5	4.35	5.54	65	50	5	6
75 × 50 × 6	5.65	7.19	75	50	6	7
80 × 40 × 6	5.41	6.89	80	40	6	7
80 × 60 × 7	7.36	9.38	80	60	7	8
90 × 60 × 8	8.97	11.4	90	60	8	8
90 × 75 × 8	9.91	12.6	90	75	8	8
90 × 75 × 10	12.2	15.6	90	75	10	8
100 × 50 × 8	8.97	11.4	100	50	8	8
100 × 65 × 7	8.77	11.2	100	65	7	10
100 × 65 × 8	9.94	12.7	100	65	8	10
100 × 75 × 10	13.0	16.6	100	75	10	10
100 × 90 × 10	14.2	18.1	100	90	10	10
120 × 80 × 10	15.0	19.1	120	80	10	11
125 × 75 × 10	15.0	19.1	125	75	10	11
125 × 90 × 10	16.2	20.6	125	90	10	11
135 × 65 × 8	12.2	15.5	135	65	8	11
135 × 65 × 10	15.0	19.1	135	65	10	11
150 × 75 × 9	15.4	19.6	150	75	9	12
150 × 75 × 10	17.0	21.7	150	75	10	12
150 × 90 × 10	18.2	23.2	150	90	10	12
150 × 90 × 12	21.6	27.5	150	90	12	12
150 × 100 × 10	19.0	24.2	150	100	10	12
150 × 100 × 12	22.5	28.7	150	100	12	12
200 × 100 × 10	23.0	29.2	200	100	10	15
200 × 100 × 12	27.3	34.8	200	100	12	15
200 × 150 × 12	32.0	40.8	200	150	12	15
200 × 150 × 15	39.6	50.5	200	150	15	15
200 × 150 × 20	52.0	66.2	200	150	20	15
200 × 150 × 25	64.0	81.5	200	150	25	15

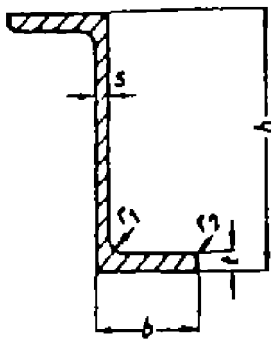
1) Weight is calculated on the basis of density of steel of 7.85 kg/dm³.

30. STRUCTURAL STEEL-ROUND EDGE ZEDS (Z-STAHL)

30.1 This Clause of the Standard specifies dimensions, mass and sectional areas of hot rolled zeds with rounded edges in accordance with DIN 1027.

30.2 Dimensions with permissible variations of hot rolled zeds are shown in Table 117 (Fig. 20).

30.3 The chemical analysis and mechanical properties shall be in accordance with ISIRI 1600.



ROUND EDGE ZEDS
Fig. 20

TABLE 117 - DIMENSIONS, WEIGHT AND SECTIONAL AREAS OF ROUND EDGE ZEDS

SYMBOL	DIMENSIONS FOR						Cross sectional area F cm²	Weigh G kg/m
	h Perm. var.	b Perm. var.	s Perm. var.	t Perm. var.	r_1	r_2		
30	30 ±1.0	38 ±1.0	4 ±0.5	4.5 ±0.5	4.5	2.5	4.32	3.39
40	40 ±1.0	40 ±1.0	4.5 ±0.5	5 ±0.5	5	2.5	5.43	4.26
50	50 ±1.0	43 ±1.0	5 ±0.5	5.5 ±0.5	5.5	3	6.77	5.31
60	60 ±1.5	45 ±1.0	5 ±0.5	6 ±0.5	6	3	7.91	6.21
80	80 ±1.5	50 ±1.0	6 ±0.5	7 ±0.5	7	3.5	11.1	8.71
100	100 ±1.5	55 ±1.5	6.5 ±0.75	8 ±0.75	8	4	14.5	11.4
120	120 ±2.0	60 ±1.5	7 ±0.75	9 ±0.75	9	4.5	18.2	14.3
140	140 ±2.0	65 ±1.5	8 ±0.75	10 ±0.75	10	5	22.9	18.0
160	160 ±4.0	70 ±1.5	8.5 ±0.75	11 ±0.75	11	5.5	27.5	21.6
180	180 ±4.0	75 ±1.5	9.5 ±0.75	12 ±0.75	12	6	33.3	26.1
200	200 ±4.0	80 ±1.5	10 ±0.75	13 ±0.75	13	6.5	33.7	30.4

31. STRUCTURAL STEEL-HOLLOW SECTIONS

31.1 This Clause of the Standard specifies the dimensions and sectional properties of hot-finished* steel circular, square, and rectangular hollow sections in accordance with ISO 657/14 (1982).

31.2 Dimensions and sectional properties of cold-finished steel structural sections are given in ISO 4019.

31.3 Dimensions and sectional properties for hot-finished hollow sections are given in the following Tables:

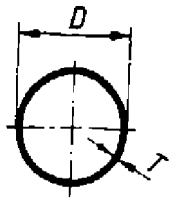
a) Circular hollow sections: Table 118.
b) Square hollow section: Table 119.
c) Rectangular hollow section: Table 120.

31.4 For all structural hollow sections the sectional properties are based on the specified outside dimensions and thicknesses.

31.5 Chemical analysis and mechanical properties of hollow section shall be in accordance with ISIRI 1600.

*** Hot-finished applies to hollow sections formed by hot forming with or without subsequent heat treatment, or by cold forming with subsequent heat treatment to obtain similar metallurgical conditions to those obtained by hot forming.**

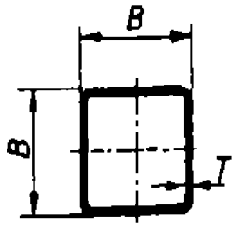
TABLE 118 - HOT-FINISHED CIRCULAR HOLLOW SECTIONS



OUTSIDE DIAMETER D	THICKNESS T	MASS PER UNIT LENGTH M	SECTION A
mm	mm	kg/m	cm²
21.3	2.3	1.08	1.37
	3.2	1.43	1.82
26.9	2.3	1.40	1.78
	3.2	1.87	2.38
33.7	2.6	1.99	2.54
	3.2	2.41	3.07
	4.0	2.93	3.73
42.4	2.6	2.55	3.25
	3.2	3.09	3.94
	4.0	3.79	4.83
48.3	2.9	3.25	4.14
	3.2	3.56	4.53
	4.0	4.37	5.57
	5.0	5.34	6.80
60.3	2.9	4.11	5.23
	3.2	4.51	5.74
	4.0	5.55	7.07
	5.0	6.82	8.69
76.1	2.9	5.24	6.67
	3.2	5.75	7.33
	4.0	7.11	9.06
	5.0	8.77	11.2
88.9	3.2	6.76	8.62
	4.0	8.38	10.7
	5.0	10.3	13.2
	6.3	12.8	16.3
101.6	3.6	8.70	11.1
	5.0	11.9	15.2
	6.3	14.8	18.9
	8.0	18.5	23.5
	10.0	22.6	28.8
114.3	3.6	9.83	12.5
	5.0	13.5	17.2
	6.3	16.8	21.4
	8.0	21.0	26.7
	10.0	25.7	32.8
139.7	4.0	13.4	17.1
	5.0	16.6	21.2
	6.3	20.7	26.4
	8.0	26.0	33.1
	10.0	32.0	40.7
	12.5	39.2	50.0
168.3	4.5	18.2	23.2
	5.0	20.1	25.7
	6.3	25.2	32.1
	8.0	31.6	40.3
	10.0	39.0	49.7
	12.5	48.0	61.2

OUTSIDE DIAMETER D	THICKNESS T	MASS PER UNIT LENGTH M	SECTION A
mm	mm	kg/m	cm²
193.7	5.4	25.1	31.9
	6.3	29.1	37.1
	8.0	36.6	46.7
	10.0	45.3	57.7
	12.5	55.9	71.2
	16.0	70.1	89.3
219.1	5.9	31.0	39.5
	6.3	33.1	42.1
	8.0	41.6	53.1
	10.0	51.6	65.7
	12.5	63.7	81.1
	16.0	80.1	102
	20.0	98.2	125
244.5	6.3	37.0	47.1
	8.0	46.7	59.4
	10.0	57.8	73.7
	12.5	71.5	91.1
	16.0	90.2	115
	20.0	111	141
273	6.3	41.4	52.8
	8.0	52.3	66.6
	10.0	64.9	82.6
	12.5	80.3	102
	16.0	101	129
	20.0	125	159
	25.0	153	195
323.9	7.1	55.5	70.7
	8.0	62.3	79.4
	10.0	77.4	98.6
	12.5	96.0	122
	16.0	121	155
	20.0	150	191
	25.0	184	235
355.6	8.0	68.6	87.4
	10.0	85.2	109
	12.5	106	135
	16.0	134	171
	20.0	166	211
	25.0	204	260
406.4	8.8	86.3	110
	10.0	97.8	125
	12.5	121	155
	16.0	154	196
	20.0	191	243
	25.0	235	300
	32.0	295	376
457	10.0	110	140
	12.5	137	174
	16.0	174	222
	20.0	216	275
	25.0	266	339
	32.0	335	427
	40.0	411	524

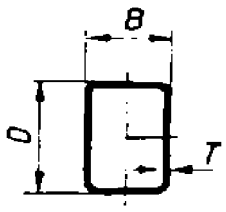
TABLE 119 - HOT-FINISHED SQUARE HOLLOW SECTIONS



SIZE B × B	THICKNESS T	MASS PER UNIT LENGTH M	SECTION A
mm	mm	kg/m	cm²
20 × 20	2.0	1.12	1.42
	2.6	1.39	1.78
30 × 30	2.0	1.74	2.22
	2.6	2.21	2.82
	3.2	2.65	3.38
40 × 40	2.6	3.03	3.86
	3.2	3.66	4.66
	4.0	4.46	5.68
50 × 50	3.2	4.66	5.94
	4.0	5.72	7.28
	5.0	6.97	8.88
60 × 60	3.2	5.67	7.22
	4.0	6.97	8.88
	5.0	8.54	10.9
70 × 70	3.2	6.67	8.50
	3.6	7.46	9.50
	4.0	8.23	10.5
	5.0	10.1	12.9
80 × 80	3.2	7.68	9.78
	3.6	8.59	10.9
	4.0	9.48	12.1
	5.0	11.7	14.9
	6.3	14.4	18.4
90 × 90	3.2	8.68	11.1
	3.6	9.72	12.4
	4.0	10.7	13.7
	5.0	13.3	16.9
	6.3	16.4	20.9
	8.0	20.4	25.9
100 × 100	3.2	9.69	12.3
	4.0	12.0	15.3
	5.0	14.8	18.9
	6.3	18.4	23.4
	8.0	22.9	29.1
	10.0	27.9	35.5
120 × 120	3.2	11.7	14.9
	4	14.5	18.5
	5	18.0	22.9
	6.3	22.3	28.5
	8	27.9	35.5
	10	34.2	43.5

SIZE B × B	THICKNESS T	MASS PER UNIT LENGTH M	SECTION A
mm	mm	kg/m	cm²
140 × 140	3.6	15.3	19.4
	5.0	20.9	26.6
	6.3	26.0	33.1
	8.0	32.4	41.3
	10.0	39.6	50.0
150 × 150	4.0	18.1	23.1
	5.0	22.5	28.6
	6.3	28.0	35.6
	8.0	34.9	44.5
	10.0	42.8	54.5
160 × 160	4.0	19.4	24.7
	5.0	24.0	30.6
	6.3	29.9	38.1
	8.0	37.4	47.7
	10.0	45.9	58.5
180 × 180	4.0	21.9	27.9
	5.0	27.2	34.6
	6.3	33.9	43.2
	8.0	42.5	54.1
	10.0	52.2	66.5
200 × 200	5.0	30.3	38.6
	6.3	37.8	48.2
	8.0	47.5	60.5
	10.0	58.5	74.5
220 × 220	5.0	33.5	42.6
	6.3	41.8	53.3
	8.0	52.5	66.9
	10.0	64.8	82.5
250 × 250	5.9	44.8	57.1
	6.3	47.7	60.8
	8.0	60.0	76.5
	10.0	74.2	94.5
260 × 260	5.9	46.7	59.4
	6.3	49.7	63.3
	8.0	62.5	79.7
	10.0	77.3	98.5
300 × 300	7.1	64.7	82.4
	8.0	72.6	92.5
	10.0	89.9	114
350 × 350	8.0	85.2	108
	10.0	106	134
400 × 400	10.0	121	154

TABLE 120 - HOT-FINISHED RECTANGULAR HOLLOW SECTIONS



SIZE D × B	THICKNESS T	MASS PER UNIT LENGTH M	SECTION A
mm	mm	kg/m	cm²
50 × 30	2.6	3.03	3.86
	3.2	3.66	4.66
	4.0	4.46	5.68
60 × 40	3.2	4.66	5.94
	4.0	5.72	7.28
	5.0	6.97	8.88
70 × 40	3.2	5.17	6.58
	4.0	6.34	8.08
	5.0	7.76	9.88
80 × 40	3.2	5.67	7.22
	4.0	6.97	8.88
	5.0	8.54	10.9
90 × 50	3.2	6.67	8.50
	3.6	7.46	9.50
	4.0	8.23	10.5
	5.0	10.1	12.9
100 × 50	3.2	7.18	9.14
	3.6	8.02	10.2
	4.0	8.86	11.3
	5.0	10.9	13.9
100 × 60	3.2	7.68	9.78
	3.6	8.59	10.9
	4.0	9.48	12.1
	5.0	11.7	14.9
	6.3	14.4	18.4
120 × 60	3.2	8.68	11.1
	3.6	9.72	12.4
	4.0	10.7	13.7
	5.0	13.3	16.9
	6.3	16.4	20.9
	8.0	20.4	25.9
120 × 80	3.2	9.69	12.3
	4.0	12.0	15.3
	5.0	14.8	18.9
	6.3	18.4	23.4
	8.0	22.9	29.1
	10.0	27.9	35.5
140 × 80	3.2	10.7	13.6
	4.0	13.3	16.9
	5.0	16.4	20.9
	6.3	20.4	25.9
	8.0	25.4	32.3
	10.0	31.0	39.5

SIZE D × B	THICKNESS T	MASS PER UNIT LENGTH M	SECTION A
mm	mm	kg/m	cm²
150 × 100	3.2	12.2	15.5
	4.0	15.1	19.3
	5.0	18.7	23.9
	6.3	23.3	29.7
	8.0	29.1	37.1
	10.0	35.7	45.5
160 × 80	3.2	11.7	14.9
	4.0	14.5	18.5
	5.0	18.0	22.9
	6.3	22.3	28.5
	8.0	27.9	35.5
	10.0	34.2	43.5
180 × 100	3.6	15.3	19.4
	5.0	20.9	26.6
	6.3	26.0	33.1
	8.0	32.4	41.3
	10.0	39.6	50.5
200 × 100	4.0	18.1	23.1
	5.0	22.5	28.6
	6.3	28.0	35.6
	8.0	34.9	44.5
	10.0	42.8	54.5
200 × 120	4.0	19.4	24.7
	5.0	24.0	30.6
	6.3	29.9	38.1
	8.0	37.4	47.7
	10.0	45.9	58.5
220 × 140	4.0	21.9	27.9
	5.0	27.2	34.6
	6.3	33.9	43.2
	8.0	42.5	54.1
	10.0	52.2	66.5
250 × 150	5.0	30.3	38.6
	6.3	37.8	48.2
	8.0	47.5	60.5
	10.0	58.5	74.5
300 × 200	5.9	44.8	57.1
	6.3	47.7	60.8
	8.0	60.0	76.5
	10.0	74.2	94.5
400 × 200	7.1	64.7	82.4
	8.0	72.6	92.5
	10.0	89.9	114
450 × 250	8.0	85.2	108
	10.0	106	134
500 × 300	10.0	121	154