SURVEYING

- Surveying is the art and sciences of determining of the relative position of different points or stations on the surface of the surface of the earth by measuring the horizontal and vertical distances, angle, and taking in details of this points and by preparing map or plan for the suitable scale.

OBJECTIVES OF SURVEYING

- The object of surveying is to prepare a map or plan to show relative position of points or the object on the surface of the earth.
- The map or plan is draw to some suitable scale. It shows the boundaries of districts, state and countries too.
- It is also include details of different engineering features such as building, roads, railways, dams, canals etc.

USES OF SURVEYING

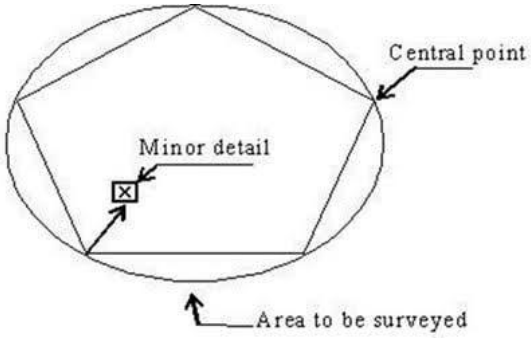
- To prepare cadastral map
- To prepare an engineering map
- To prepare the contour map
- To prepare military map
- To prepare geological map, archeological map etc.

PRINCIPLES OF SURVEYING

- Always work from the whole to the part
- To locate a new station by at least two measurement form fixed reference points

- **Work from whole to part**

This surveying principle involves laying down an overall system of stations whose positions are fixed to a fairly high degree of accuracy as control, and then the survey of details between the control points may be added on the frame by less elaborate methods. Errors which may inevitably arise are then contained within the framework of the control points and can be adjusted to it.



- **Fixing a point with reference to other points**

According to this principle, the relative position of a point to be surveyed should be located by measurement from at least two points of reference, the positions of which have already been fixed.

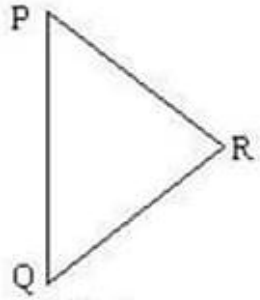


Fig. a

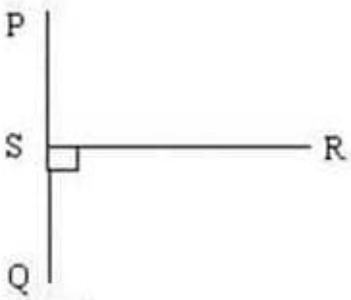


Fig. b

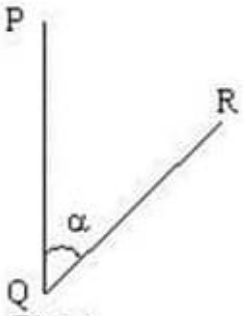


Fig. c

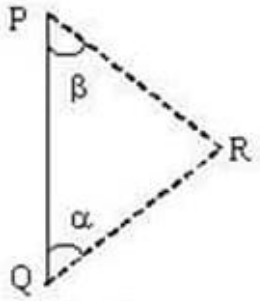


Fig. d

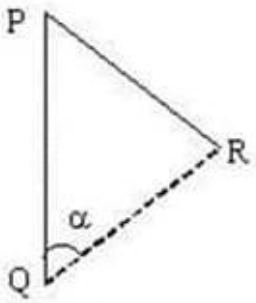


Fig. e

If P and Q are the two reference points on the ground, any other point, such as R, can be located by any of the direct methods shown in the above figures. But, although a single method is sufficient to locate the relative position of 'R' with respect to reference points P and Q, it is necessary to adopt at least any two methods to fix the position of point 'R'.

CONSTRUCTION MATERIALS

BRICKS

Classification of Bricks

Bricks are classified as follows:

- Unburnt bricks or sun dried bricks
- Burnt bricks

Another classification is based on the quality of bricks

 First class bricks

 Second class bricks

 Third class bricks

 Fourth class bricks

➢ *Unburnt bricks*

• These are dried under sunlight.

• They are used for temporary and cheap construction.

• It is used for filling works.

➢ *Burnt bricks*

• The bricks which are burnt in a kiln after drying are called burnt or pucca bricks.

➢ *First class bricks*

• They are well burnt having smooth and even surface with perfect rectangular shape

• These are machine moulded

• Uniform reddish colour

• Used for superior quality works such as outer walls, facing works and floor.

• Should not have any defects like cracks, stones or lumps of clay

• These should not leave any mark when scratched by finger nail

• When broken into two pieces, broken faces should be of compact structure

• Minimum compressive strength of these bricks should be 10.5 N/mm²

➢ *Second class bricks*

• These bricks are with slight irregularities in shape, size, colour and surface finish.

• Slightly over burnt.

• These bricks are ground moulded & burnt in kilns.

Properties are

– They should not absorb water more than 22% of its weight when immersed in cold water for 24 hours

– Minimum compressive strength of these bricks should be 7 N/mm²

• Used for internal walls

• Should be plastered.

➢ *Third class bricks*

• These are not burnt properly (under/over burnt)

• They are ground moulded & burnt in clamps.

• Light red in colour with yellowish tint

• They should not absorb water more than 24% of its weight when immersed in cold water for 24 hours

• Minimum compressive strength of these bricks should be 3.5 N/mm²

• Used for unimportant and temporary works

➢ *Fourth class /Over burnt bricks*

• These are over burnt bricks

• These bricks are dark in colour with irregular size and shape

• Not used for building construction

• Used as aggregate in concrete and for flooring

Qualities of good bricks

• The brick should have uniform copper colour.

• Brick should be uniform in shape and should be of standard size

• The surface should be even and free from cracks & voids.

• It should have even surfaces with sharp & square edges.

• Bricks when broken should show a bright homogeneous structure.

• It should be sufficiently hard. When scratched with a finger nail, no impression should be left on brick surface.

• It should give a clear ringing sound when knocked with each other.

• It should not absorb water more than 20% by weight when immersed in cold water for 24 hours.

• Brick should not break when dropped flat from a height of 1 m.

• It should not have crushing strength value below 3.5 N/mm^2

.• It should be sound proof and should have low thermal conductivity.

Uses of bricks

- Construction of walls of any size
- Construction of floors
- Construction of arches and cornices
- Construction of brick retaining wall
- Making Khoa (Broken bricks of required size) to use as an aggregate in concrete
- Manufacture of surki (powdered bricks) to be used in lime plaster and lime concrete

CEMENT

Cement is broadly described as material having adhesive and cohesive property with capacity to bond the material like stone, bricks, building blocks etc.

It is a binder, which sets and hardens independently, and can bind other materials together.

They are inorganic material that shows the cementing properties of setting and hardening when mixed with water.

Cement is prepared by mixing calcareous (Ca) material and argillaceous and siliceous material.

Natural cement is obtained by burning and crushing of 20-40% clay, carbonate of lime and small amount of magnesium carbonate.

It is brown in colour and its best variety known as Roman cement.

It resembles very costly eminent hydraulic lime and sets very quickly after addition of water.

Not so strong as compare to artificial cement & hence finds very limited application.

Types of cement

• Ordinary Portland cement

- Most common type of artificial cement.
- Invented by Joseph Aspdin of England in 1824.
- When hardened, it resembles to a sand stone which was found plenty at a place called Portland in England. Hence, the cement is referred to as OPC.
- In India, cement was first manufactured by Indian Concrete Co. Ltd at Porbander in 1914.

• *Rapid hardening cement*: produced by burning the raw material at high temperature and by

incrasing lime content. It has the quality of attaining high strength in short period. Used in works wherein speed of construction is needed.

• *Quick setting cement*: adding aluminium sulphate and reducing gypsum. Used for under water concreting.

• *Coloured cement*: required color is obtained by adding coloring materials with the cement. Used for external finishing of walls and floors, used for garden path, swimming pools and tennis court

• *White cement*: does not contain coloring ingredients and the cement is burnt by oil. Used for floor finish, plastering, pointing of masonry, tiles and color cement and runway markings

- *Portland pozzolona cement*: mixture of Portland clinker and pozzolana with addition of gypsum and uniform blend of Portland cement and fine pozzolana. The cement takes more time for initial setting which helps in works which involve delayed construction.

• *Masonry cement*: slow hardening, high workability, high water retentivity which makes it especially suitable for masonry work.

• *Hydrophobic cement*

• *Sulphate resisting* cement: high resistance to sulphate

• *Acid resisting cement*: high resistance to sacids. Used in chemical industry.

• *High alumina cement*

• *Low heat Portland cement*: used for mass concreting of dams

• *Expanding cement*: unlike the conventional cement of shrinking, it expands during curing. Used for repairing concrete surfaces

Properties of cement

Physical properties

- Colour should be uniform.
- Should be free from lumps.
- Should be cool when felt with hand.

- Should sink when thrown in a bucket of water.

Chemical properties

- Should contain all the chemical constituents in required proportion when determined by chemical composition test.

Engineering properties

- Compressive strength value should not be less than 11.5 N/mm^2 after 3 days and 17.5 N/mm^2 after 7 days.
- Tensile strength value should not be less than 2 N/mm^2 and 2.50 N/mm^2 after 7 days
- Initial setting time should not be less than 30 min.
- Final setting time should not be more than 10 hours.
- Fineness of cement should not be more than 10%.- Sieve test (90 micron sieve)
- Soundness of cement by Le chatelier test should not exceed 10 mm.

Uses of cement

• For the preparation of cement mortar, cement concrete and reinforced concrete.

• Cement mortar is used as binding material in brick and stone masonry.

• Cement mortar is used to cover surfaces of masonry, beams and columns.

• Cement mortar is used for different types of floors and floor finishes.

• Cement is used for the manufacture of pipes and posts.

SAND

Sand is an important building material. It abundantly occurs in nature and is formed by the decomposition of rocks. Sand particles consist of small grains of silica (SiO_2). It forms a major ingredient in concrete, lime mortar, cement mortar, etc.

Types of sand

Based on source of sand, there are two types

- Natural sand
- Artificial sand

Natural sand

Natural sand is obtained from natural sources by weathering of rocks. Following are the main types of natural sand

Pit Sand (Coarse sand)

Pit sand is classified under coarse sand which is also called Badarpur in common language. This type of coarse sand is procured from deep pits of abundant supply and it is generally in red-orange color. The coarse grain is sharp, angular and certainly free from salts etc which is mostly employed in concreting.

River Sand

This is generally gathered from the banks of the river. It has a fine quality, unlike pit sand. This sand is usually whitish grey in color and has rounded particles. This sand is very much useful for construction purpose such as plastering and so on.

Sea sand

This is obtained from sea shores. It is brown in color and it also has the fine rounded grain. As it is obtained from sea it contains salt, which is used in attracting moisture from atmosphere. Such absorption causes dampness and disintegration of work. It is generally not used for engineering purpose due to its retards setting action of cement. It is normally used for non structural purposes.

Crushed Stone Sand/ Artificial Sand/ M Sand

It is a substitute for River Sand, it is also known as fine aggregates which are manufactured by crushing either granite or basalt rock using 3 stage crushing process by some companies. This sand is manufactured in conformance to IS Codes and is an effective alternative to river sand also known popularly as M Sand.

Classification of sand

Based on the grain size distribution

Fine sand:

The sand passing through a sieve with clear openings of 1.5875 mm is known as fine sand. Fine sand is mainly used for plastering. .

Coarse sand: The sand passing through a sieve with clear openings of 3.175 mm is known as coarse sand. It is generally used for masonry work.

Gravelly sand: The sand passing through a sieve with clear openings of 7.62 mm is known as gravelly sand. It is generally used for concrete work.

Properties of sand as a construction material

- It should be clean and coarse.
- It should be free from any organic or vegetable matter;
- Usually 3-4 per cent clay is permitted.

- It should be chemically inert.
- It should contain sharp, angular, coarse and durable grains.
- It should not contain salts which attract moisture from the atmosphere.
- It should be well graded, i.e., it should contain particles of various sizes in suitable proportions. It should be strong and durable.
- It should be clean and free from coatings of clay and silt.

uses of sand

- sand is in very commonly use in construction, often providing bulk, strength and stability to other materials such as asphalt, concrete, mortar, render, cement, and screed.
- Sand is also used as a base layer known as 'blinding' that is laid above a layer of hardcore to provide a clean, level and dry surface for construction works.
- It can also be used in its raw form as a decorative material in landscaping.
- Sand is used in liquid form to manufacture glass, and is also used for moulding metal casting.
- It can be used as an abrasive in the process of sandblasting which cleans structural elements, steelwork, and so on.
- Sandpaper is also made using sand.

TIMBER

Timber denotes wood which is suitable for building or carpentry and for various engineering and other purposes.

There are two main types of wood - hardwoods and softwoods.

- *Hard woods*

Hard woods come from broad leaved trees. These trees have flowers and produce seeds such as nuts and fruit). Examples are oak, beech and mahogany.

Hardwoods are denser than softwoods and are stronger and more durable too. They are used for furniture making. Hardwoods are much more expensive than softwoods.

- *Soft woods*

Soft woods come from cone bearing trees. Examples are pine, redwood and fir. Softwoods can be used for furniture and doors but are mostly used in construction for roof trusses and stud partitions.

properties of good timbers

- Strong, stiff, tough & durable
- Free from natural & artificial defect
- Color should be dark as it indicate strong & durable timber
- Structure should be uniform
- Have a good workability
- Density should be high
- Have a sweet smell
- should have elasticity
- Should be resistant to compression
- Should be fire resistant

- Should have law water permeability

Uses of timber

- Building construction
- House post construction
- Construction of bridge and boat •
- Furniture & instrument
- Railway slipper
- Formwork of cement concrete

• Beam • Trusses • Rafters • Doors frame and shutters • Windows frame and shutters • Stair cases • Poles • Piles • Columns

CONCRETE

Artificial building material obtained by mixing cement, fine aggregate, coarse aggregate, water in predetermined proportion. Cement acts as a binding material. When mixed they form plastic material. Fine aggregates fill the voids of coarse aggregate and voids of fine aggregate are filled with cement. Also cement reacts with water and binds the aggregate together to form a hard material called concrete. Concrete has enough strength in compression, but has little strength in tension. Steel bars may be used – to take tensile stresses – reinforced cement concrete

TYPES OF CONCRETE

Concrete are classified into different types:

1. According to binding material used in concrete.

2. According to design of concrete.

3. According to purpose of concrete.

According to binding material:

According to binding material used concrete is classified into two types.

(1) Cement concrete (2) Lime concrete.

Cement concrete

In cement concrete useful proportions of its ingredients are 1 part cement:1-8 part sand:2-16 parts coarse aggregates.

Uses : Cement concrete is commonly used in buildings and other important engineering works where strength and durability is of prime importance.

Lime concrete

The concrete consisting of lime, fine aggregates, and coarse aggregates mixed in a suitable proportions with water is called lime concrete. In this type of concrete hydraulic lime is

generally used as a binding material, sand and cinder are used as fine aggregates and broken bricks, gravel can be used as coarse aggregates.

According to design of concrete

(1) Plain cement concrete.

(2) Reinforced cement concrete(RCC).

(3) Pre-stressed cement concrete(PCC).

Plain cement concrete

The cement concrete in which no reinforcement is provided is called plain cement concrete or mass cement concrete. This type of concrete is strong in taking compressive stresses but weak in taking tensile stresses.

Uses: Plain cement concrete is commonly used in for foundation work and flooring of buildings.

Reinforced cement concrete(rcc)

The cement concrete in which reinforcement is embedded for taking tensile stress is called reinforced cement concrete. In this type of concrete the steel reinforcement is to be used generally in the form of round bars,6mm to 32mm dia. This concrete is equally strong in taking tensile, compressive and shear stresses. Usual proportions of ingredients in a reinforced concrete are 1part of cement:1-2parts of sand: 24parts of crushed stones or gravel.

Uses: RCC is commonly used for construction of slabs, beams, columns, foundat ion, precast concrete.

Pre-stressed cement concrete (pcc)

The cement concrete in which high compressive stresses are artificially induced before their actual use is called pre-stresses cement concrete. in this type of cement concrete, the high compressive stresses are induced by pretensioning the reinforcement before placing the concrete, and the reinforcement is released when final setting of the concrete take place. Uses : This concrete can take up high tensile and compressive stresses without development of cracks. The quantity of reinforcement can be considerably reduced by using this concrete.

According to purpose concrete can be

a. *Vacuum Concrete*:

The cement concrete from which entrained air and excess water is removed after placing it, by suction with the help of vacuum pump is called vacuum concrete. In this concrete the excess water which is added to increase workability but not required for the hydration of cement of concrete is removed by forming vacuum chamber

b. *Air Entrained Concrete*

The concrete prepared by mixing aluminum in it is called air entrained, cellular or aerated concrete. In this concrete bubbles of hydrogen gas are liberated which forms cell and make the concrete cellular.

Uses: This concrete is used for lining walls and roofs for heat and sound insulation purpose.

c. Light Weight Concrete

The concrete prepared by using coke breeze, cinder or slag as coarse aggregate is called light weight concrete. The concrete is light in weight and posses heat insulating properties.

Uses This concrete is used in making precast structural units for partition and wall lining.

Constituent materials

• *Cement*

– Most important ingredient

– Used to bind fine & coarse aggregate together

– Commonly used – OPC

– Other types of cement are used under certain circumstances

• *Fine aggregate*

– Make the concrete denser by filling the voids

– Also make concrete mix economical

– Reduce shrinkage of concrete on hardening – Should be inert or chemically inactive

• *Coarse aggregate*

– Retained on 4.75 mm sieve and passing 60 mm

– Inert material – eg – uncrushed gravel, broken bricks, crushed stone etc

– Make the concrete strong and tough MODULE 4 15

– Increases the volume of concrete and about 75% of whole concrete is only aggregate

• Water

– Should be clean and free from harmful substances such as oils, acids, alkalies, salts etc. – Potable water (fit to drink) is satisfactory for both mixing and curing – Serves following function:

- Acts with cement to form a paste for binding the aggregate
- Enables concrete to flow in to moulds

- Normal water/cement = 0.6

Properties of Cement Concrete

• High compression and weak in tension

• Hardens with age

• It shrinks due to loss of water

• Free from corrosion

• Can sustain any atmospheric effects

• Fire resistant capacity

• More economical and durable

• It forms a hard surface which is capable to resist abrasion

STEEL

Steel is an alloy made by combining iron and other elements, the most common of these being carbon.

Types of steel Based on carbon content

- Mild steel – 0.15 to 0.25%
- Medium carbon steel - 0.25 to 0.6% (rail wheels)
- High carbon steel - 0.6 to 1.5%

Steel is used structurally in two ways

- **Reinforcement steel**
- **Structural steel**

Reinforcement steel

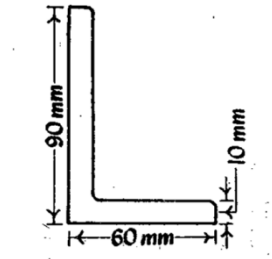
- Concrete is weak in tension but strong in compression. Steel is strong in tension

  So inorder to improve tensile strength of concrete, Steel bars are embedded in concrete and it is known as reinforcement

  Types of reinforcing bars

- **Mild steel and medium tensile steel / Plain steel bars**
  - Round sections
  - Mild steel / medium tensile steel / plain steel bars

- Plain steel bars – diameter from 5mm to 32mm
- Designated as Fe250
- Yield strength – 250 N/mm^2



Unequal angle section
FIG. 10-4

- **High yield strength deformed bars (HYSD)/ TOR steel**
  - Cold twisted deformed bars
  - Tor steel bars – longitudinal ribs in the form of continuous helix
  - Develop high bond strength due to interlocking with concrete
  - Mean diameters – 5mm to 40mm

STRUCTURAL STEEL SECTIONS/ MARKET FORMS OF STEEL

1. Angle sections
2. Channel sections
3. I-sections
4. T-sections
5. Flat sections
6. Steel plates
7. Corrugated sheets
8. Round bars
9. Square bars

1. Angle sections

- Known as Rolled Steel Angle Sections (ISA)
- Designated as ISA with size of legs and its thickness.

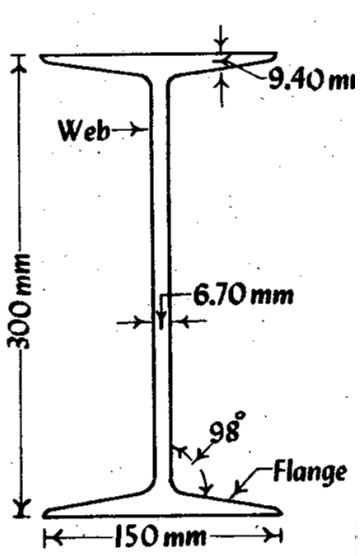
Available as

- Equal angle sections
  - Two legs will be equal in length
  - Available in sizes varying from 20mm x 20mm x 3mm to 200mm x 200mm x 25mm
- Unequal angle sections
  - Two legs will be unequal in length.

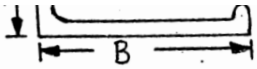
- Available in sizes varying from 30mm x 20mm x3mm x 3mm to 200mm x 150 mm x 18mm

➢ Bulb angle sections
- Have bulb portion at the ends of the legs.
- Extensively used in structural steel works like roof trusses, and as connecting members for different structures.

Channel sections
- Known as Rolled Steel Channel Sections
- Consists of a web and two equal flanges.
- Designated by height of web and width of flange
- Available in sizes varying from 100mm x 45mm to 400mm x 100mm.
- Widely used for beams and columns.
- The different types available are:
  - ➢ Indian Standard Junior Channel (ISJC)
  - ➢ Indian Standard Light Channel (ISLC)
  - ➢ Indian Standard Medium Channels (ISMC)

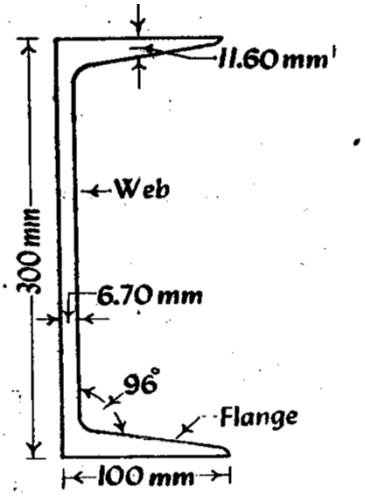


I-section
FIG. 10-7



2. I- sections

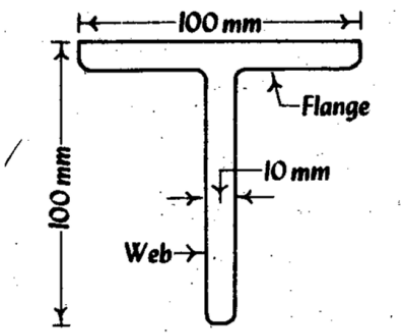
Rolled Steel I – Sections
- Known as rolled steel joists or beams.
- Consists of two flanges connected by a web.
- Designated of overall depth and width of flange.
- Available in sizes varying from 75mm x 50mm to 600mm x210mm.
- Different types are:
  - ➢ Indian Standard junior beam (ISJB)
  - ➢ Indian Standard Light Beam (ISLB)
  - ➢ Indian Standard Medium Beam (ISMB)
  - ➢ Indian Standard Wide Flange Beam (ISWB)
  - ➢ Indian Standard Heavy Beam (ISHB)
- Strongest and most economical of all sections
- Used as columns, purlins in trusses and grillage foundations.



Channel section
FIG. 10-5

- **4. T- sections**
- **Rolled steel Tee sections:**
  - Resembles the alphabet **T**
  - Consists of web and flange
  - Designated by overall dimensions and thickness.

- Available in sizes varying from 20mm x 20mm x 3mm to 150mm x 150mm x 10mm.
- Widely used as members of the steel roof truss and form built – up sections.
- Different types available are:
  - Indian Standard Normal Tee (ISNT)
  - Indian Standard Heavy Tee (ISHT)
  - Indian Standard Short Tee (ISHT)
  - Indian Standard Junior Tee (ISHT)



T-section
FIG. 10-8

- **5. Flat sections**
- **Indian Standard Flats (ISF):**
  - Designated as ISF 10 x 3(flat of width 10mm and thickness 3 mm).
  - Available in suitable widths varying from 10mm to 400mm
  - Thickness varying from 3mm to 40mm.
  - Used for steel grillwork for windows and gates.
- **6. Steel plates**
- **Rolled Steel Plate Section (ISPL):**
  - Designated as ISPL 500 x 5 (500mm width and 5mm thickness)
  - Used for construction of water tanks and other storage structures, built up beams, columns, base plate for foundations etc.
- **Rolled Standard Sheet Sections (ISSH):**
  - Plates having thickness less than 5mm.
  - Designated as ISSH 1800 x 600 x 4 (sheet having length 1800mm, breadth 600mm and thickness 4mm).
  - Used for construction of boxes and vehicle bodies.
- **Indian Standard Strips (ISST):**
  - Mainly used as beedings.
  - Designated as ISST 100 x 2 (steel strip with a width of 100mm and thickness 2mm).

Corrugated sheets

- Formed by passing steel sheets through grooves.
- Grooves bend and press steel sheets and corrugations are formed on the sheet.
- GI sheets are common.

Used as roof coverings

Round bars

- **Rolled steel bar section:**
  - Indian Standard Round Bars (ISRO):
    - Designated as ISRO 10 (round bars having diameter 10mm)
    - Available in diameter varying from 6mm to 25mm.
- **Rolled Steel Tubes:**
  - Inner diameter varying from 15 to 150mm.

- Thickness varying from 2 to 5.4mm.
- Efficient structural sections for formwork and trusses

Square sections

- **Indian Standard square bars (ISSQ):**
    - Designated as ISSQ 10 (square bars of size 10mm)
    - Used for grillwork, handrails for staircases etc.