11 Developments and Envelopments

SYLLABUS OUTLINE

Areas to be studied:

• Surface development and envelopment of right solids. • *Surface development and envelopment of oblique solids.*

Learning outcomes

Students should be able to:

Higher and Ordinary levels

- Develop and envelop of right regular solids, their composites and frustra.
- Determine and project true distance lines between specified points on the surfaces of solids.

Higher level only

- *Develop and envelop the surfaces of oblique prisms and pyramids.*

Developments

The development of a surface is that surface laid out on a plane. The faces or surfaces of an object are unfolded onto a single plane. Fold lines are indicated by dashed lines.

A large number of industries rely on developments, for example, cardboard cartons are used for packaging and marketing manufactured goods. These cartons are usually made from a single sheet of cardboard. Sheet metalworkers continuously use developments as does the clothes industry.

In a development all lines are true lengths and all surfaces are true shapes.

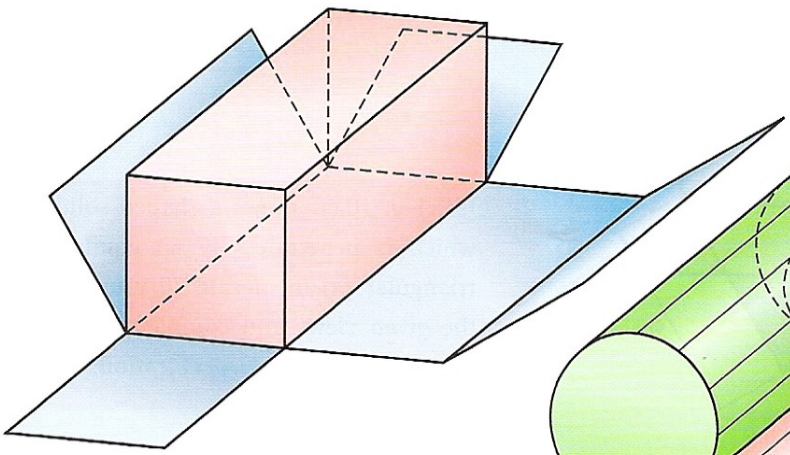


Fig. 11.1a

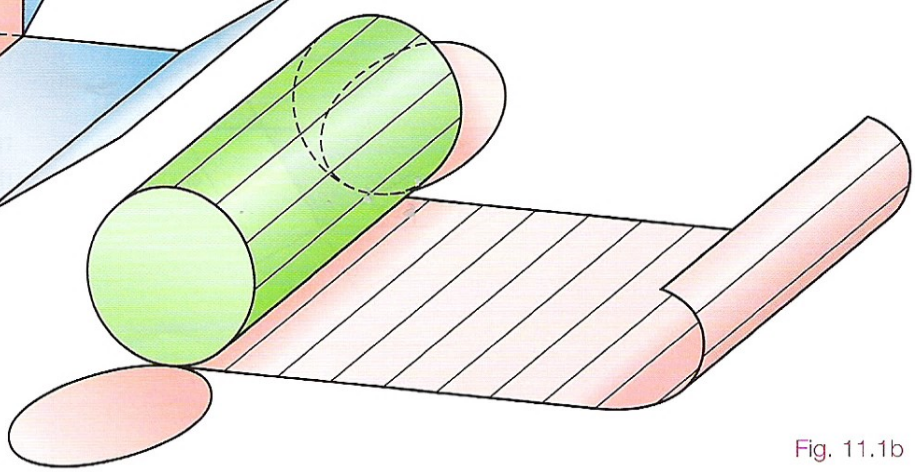


Fig. 11.1b

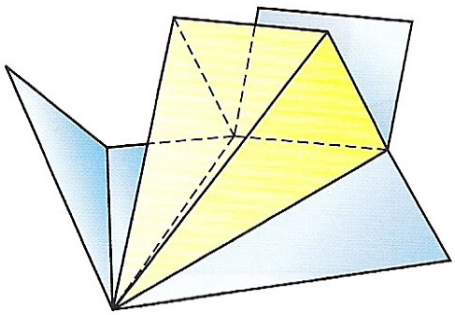


Fig. 11.1c

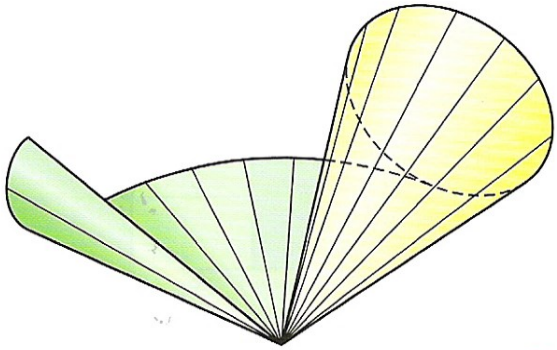


Fig. 11.1d

Given the plan and elevation of a rectangular prism. To draw the complete surface development. Fig. 11.2.

(1) Project lines from the elevation to obtain the heights of the sides.
(2) Step-off the lengths of the sides with a compass taking distances from the plan, 2–3, 3–4, 4–1, 1–2.
3) Point 2 appears twice in this example because it forms the seam. The size of both top and bottom matches those of the plan. Dotted lines represent fold lines.

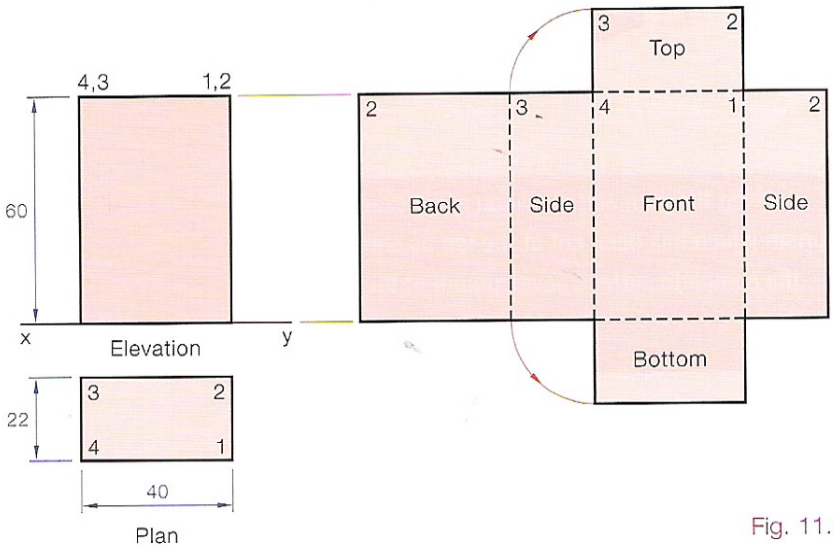


Fig. 11.2

To draw the development of a truncated prism given its plan and elevation. Fig. 11.3

(1) Project lines from the elevation to obtain the heights for the sides.
(2) The width of each face is taken from plan.
(3) The length of the top surface must match that of the sloped surface on the front or back.
(4) Project lines perpendicularly to one of these sloped lines and complete the top as shown in Fig. 11.3.

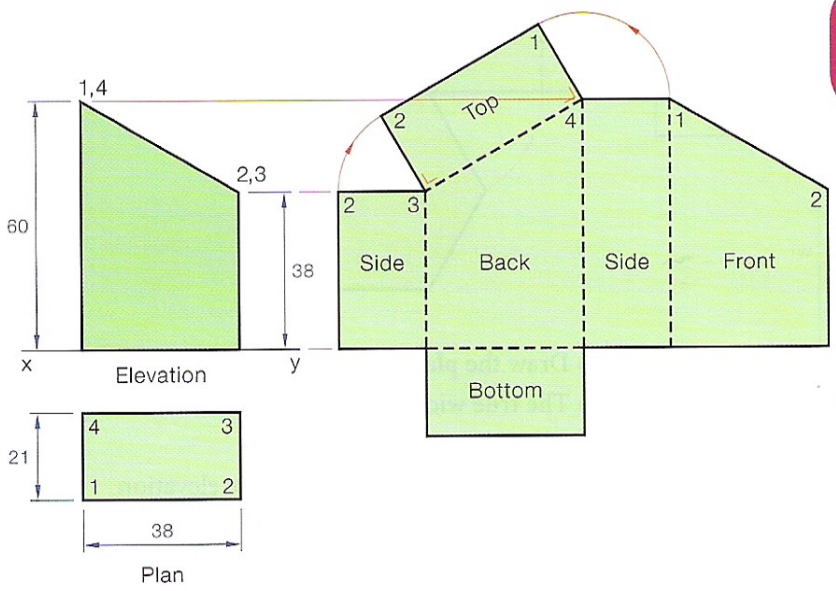


Fig. 11.3

To draw the development of a truncated pentagonal prism given its plan and elevation. Fig. 11.4

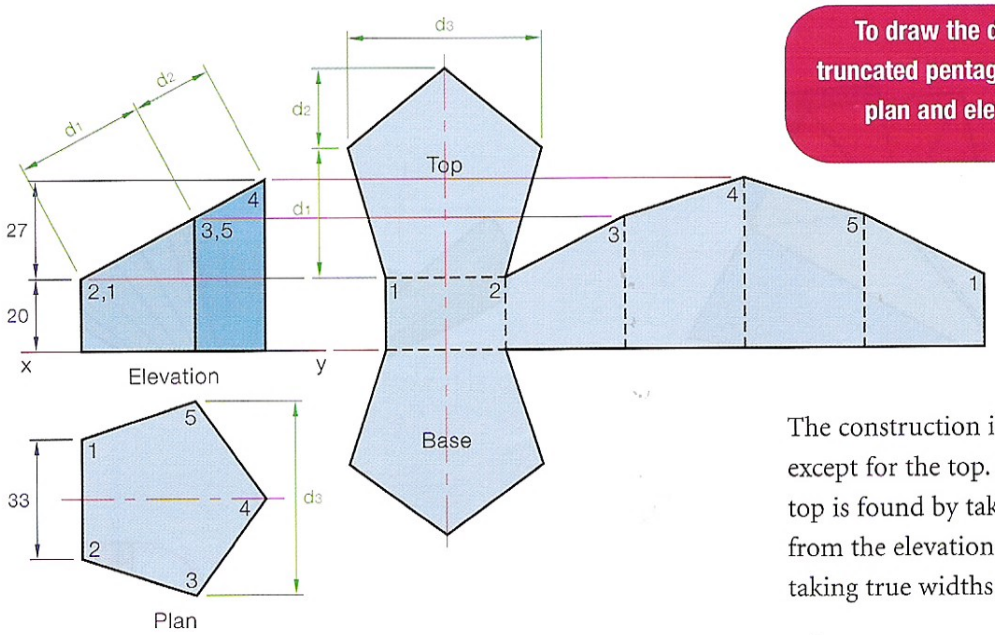


Fig. 11.4

The construction is similar to Fig 11.3 except for the top. The true shape of the top is found by taking the true lengths from the elevation (d_1 and d_2) and taking true widths from the plan (d_3).

Given the plan and elevation of a hexagonal prism which has been cut at the top as shown. Draw the complete surface development of the prism. Fig. 11.5

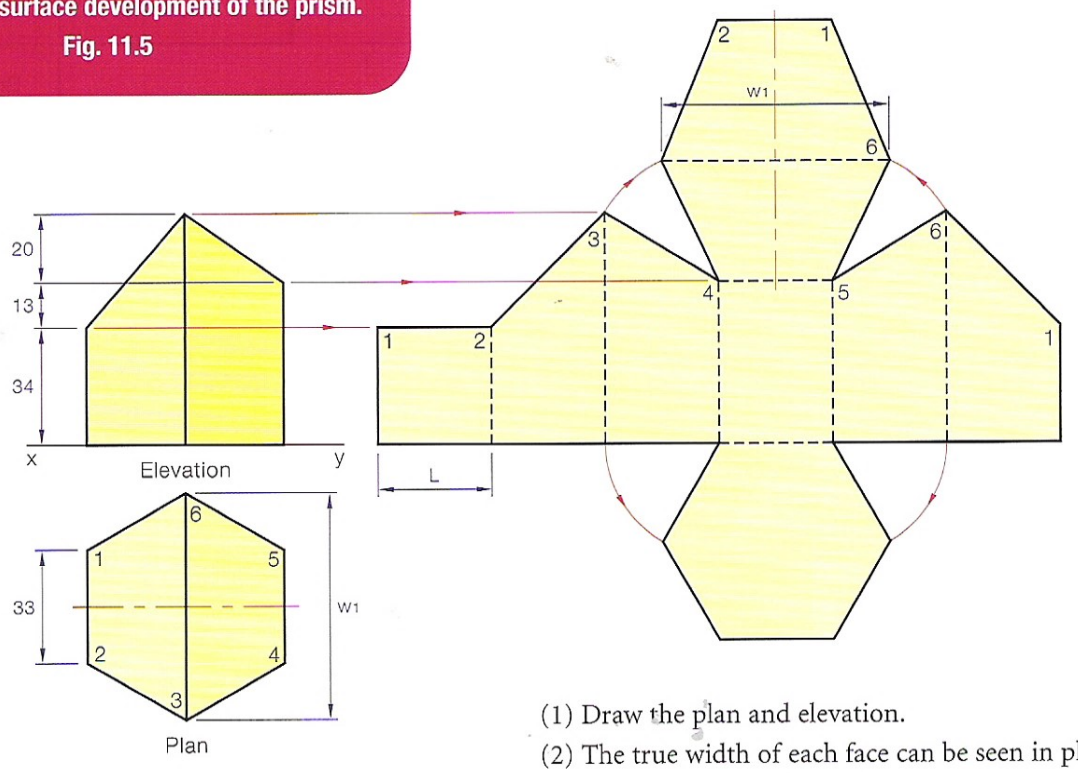


Fig. 11.5

(1) Draw the plan and elevation.
(2) The true width of each face can be seen in plan, 33 mm. Step six of these off.
(3) Heights are projected from the elevation.
(4) The top is developed by taking true lengths off the elevation and true widths off the plan. Seams that join together must be of equal length.

To draw the development of a cylinder. Fig. 11.6

(1) Divide the circumference of the circle in plan into twelve equal parts in the usual way.
(2) Project the top and bottom of the elevation across to obtain the height of the development.
(3) Step-off the twelve steps from the plan (the circumference).
(4) It does not matter where the top and bottom circles are added on the top and bottom lines.

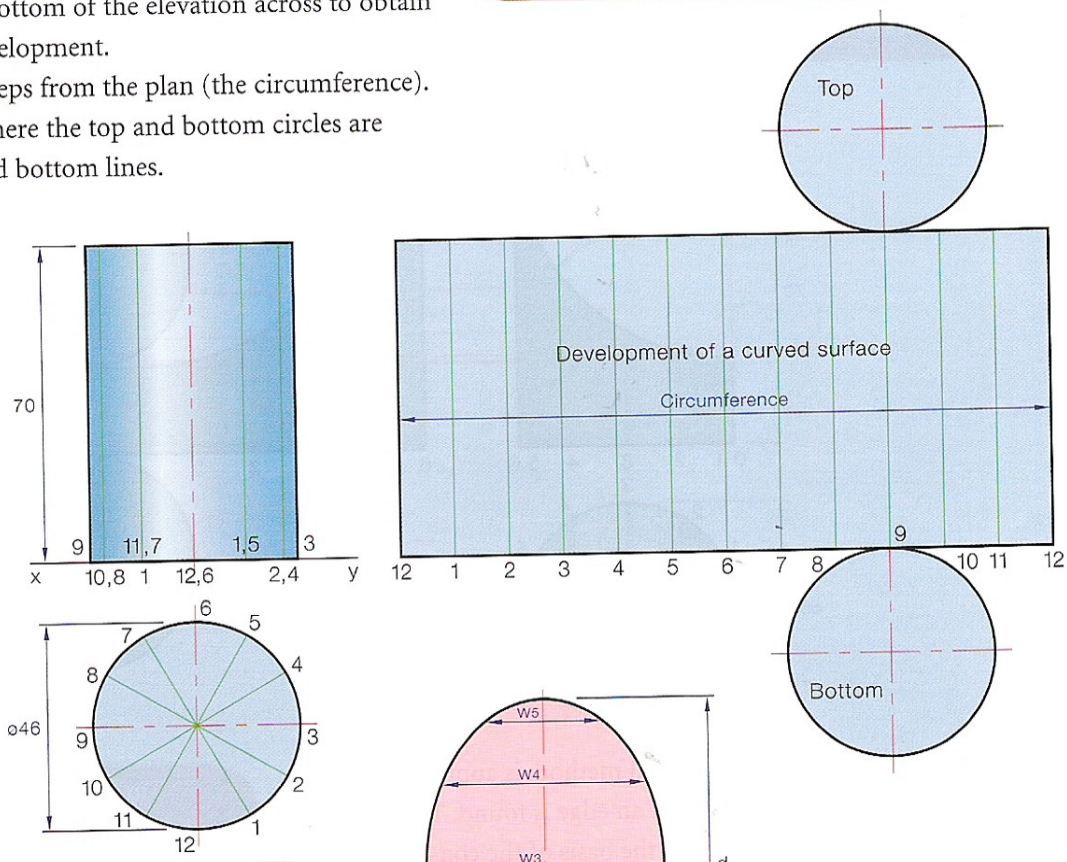


Fig. 11.6

To draw the complete surface development of a truncated right cylinder. Fig. 11.7

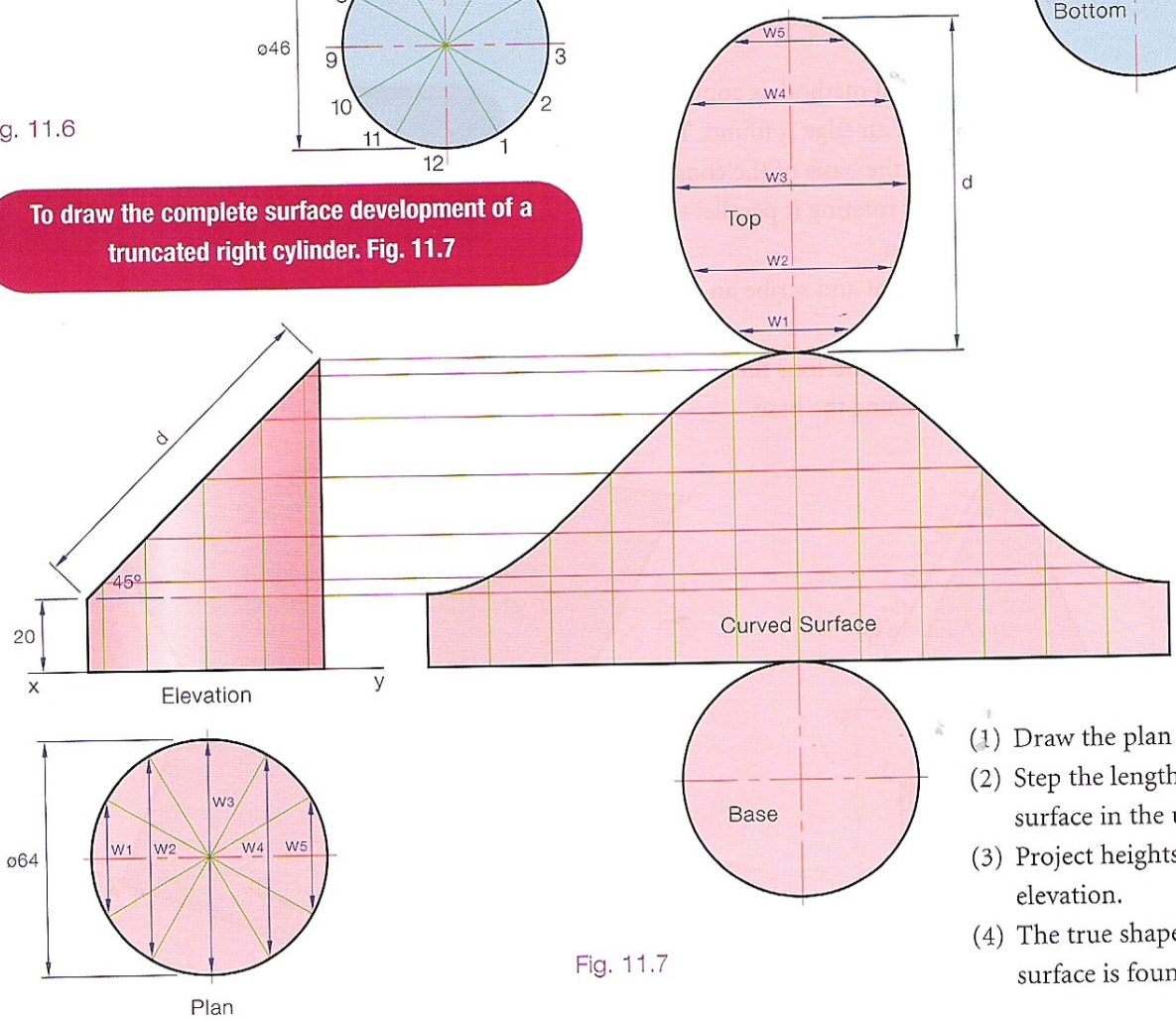


Fig. 11.7

(1) Draw the plan and elevation.
(2) Step the length of the curved surface in the usual way.
(3) Project heights from the elevation.
(4) The true shape of the cut surface is found and attached.

To develop the complete surface development of the cylinder which has been cut as shown in the plan and elevation. Fig. 11.8

The construction is the same as in the previous example. The top surface is curved and is found by taking lengths off the curve in elevation.

The smaller the steps taken the more accurate the result. The widths are taken from the plan and are true lengths.

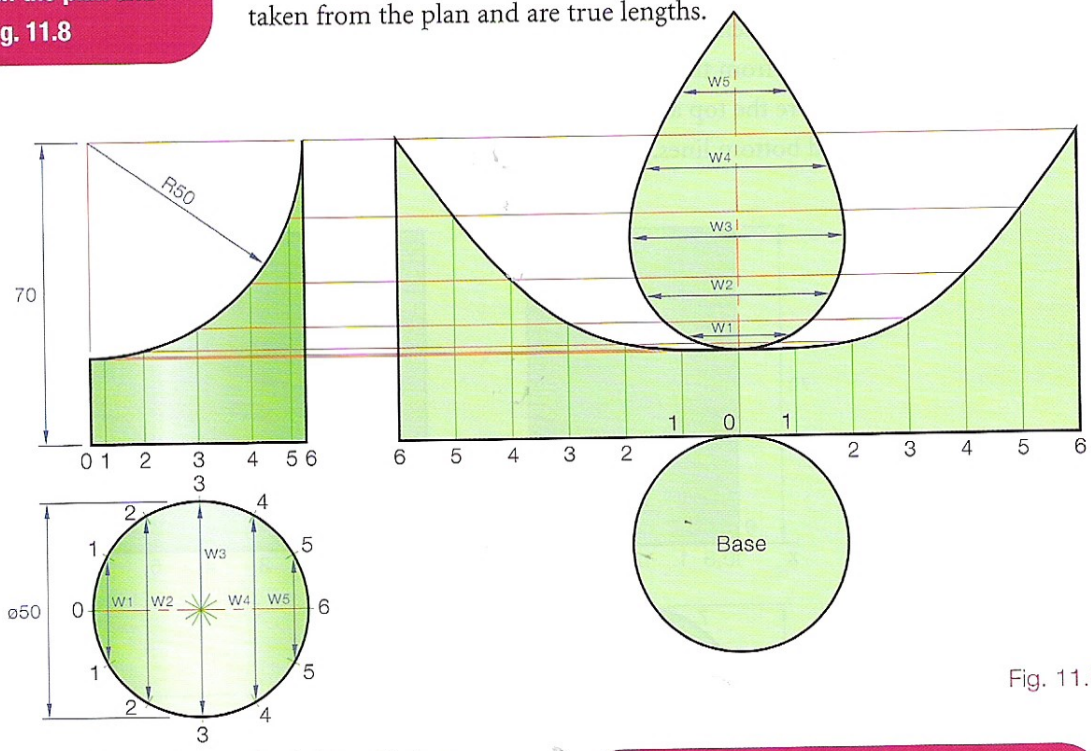
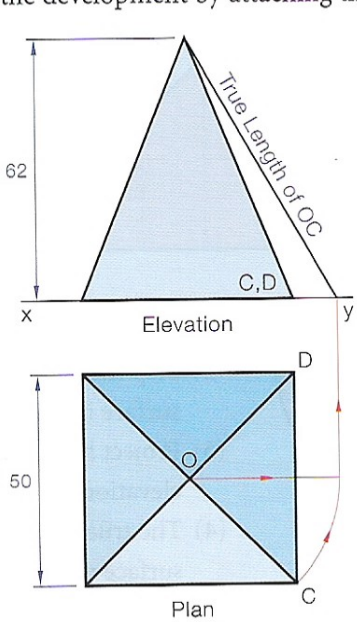


Fig. 11.8

This method, sometimes called the radial method, is applied to pyramids and cones. The true length of an edge is found. This length is used as the radius of an arc which is the basis of the construction.

(1) Find the true length of edge OC by rotating it parallel to the xy in plan and projecting it to elevation.
(2) Choose a point O for the development and scribe an arc having the true length of OC as radius.
(3) Step the length of the base around the arc four times.
(4) Complete the development by attaching the base.

To draw the complete surface development of a square-based pyramid given its plan and elevation. Fig. 11.9



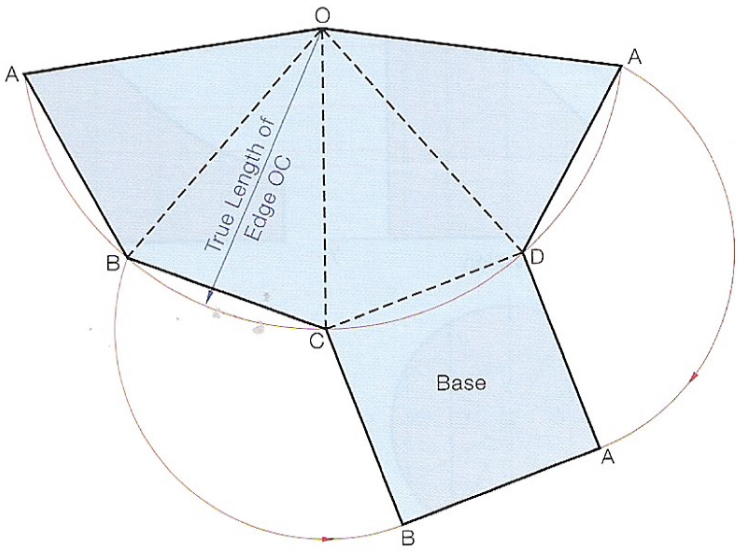
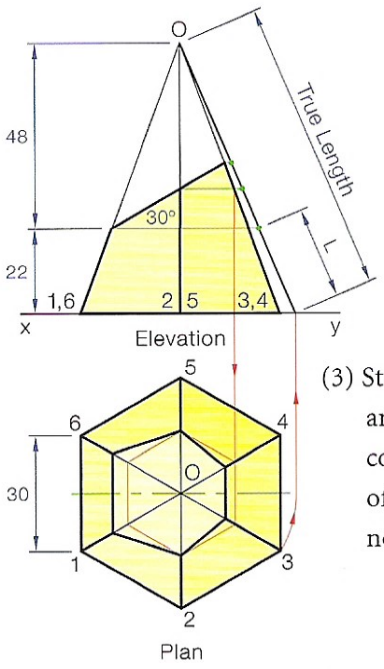


Fig. 11.9

To draw the surface development of a truncated hexagonal pyramid given its plan and elevation. Fig. 11.10

(1) The true length of an edge is first found as shown in plan and elevation.
(2) This true length is used to draw the arc for the development.



(3) Step the six hexagon sides around this arc and thus complete the development of the pyramid as if it has not been cut.

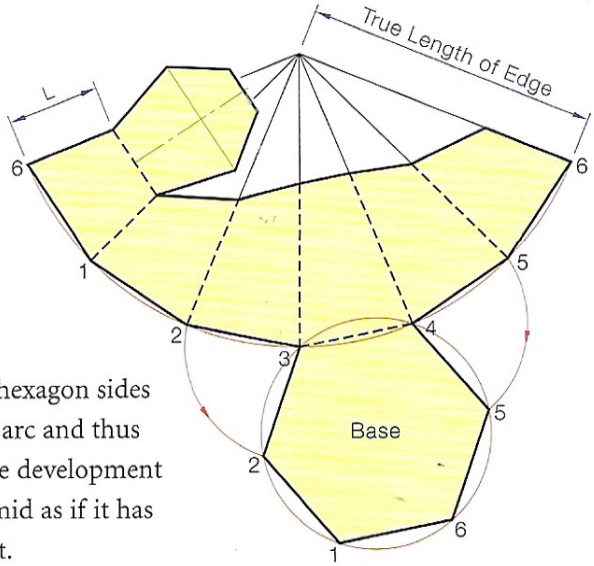
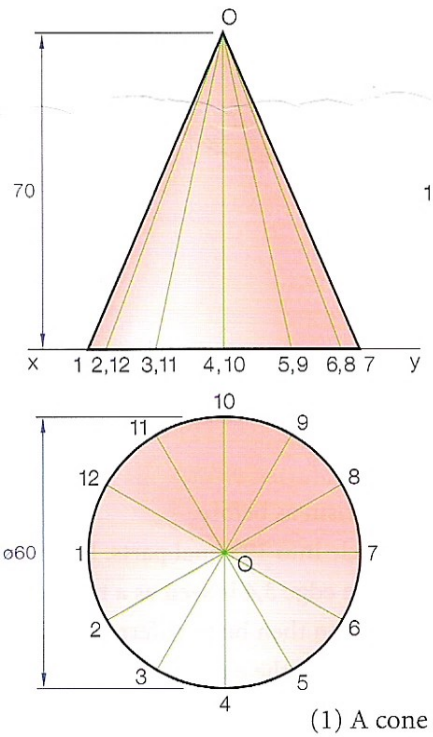


Fig. 11.10

(4) The true length of each cut edge is now found and stepped-off on the development.
(5) The cut surface itself is found in the usual way.



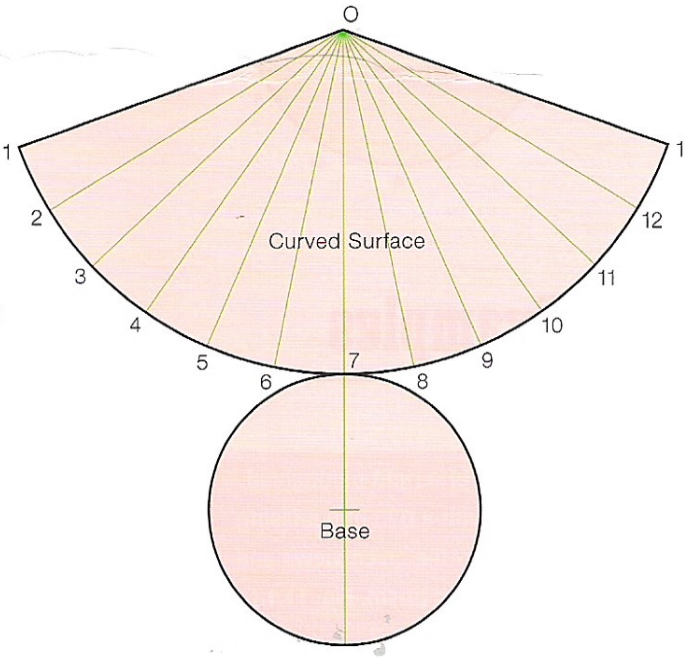


Fig. 11.11

To develop the complete surface development of a cone given its plan and elevation. Fig. 11.11

(1) A cone is developed in exactly the same way as a pyramid.
(2) The plan is divided into twelve equal pieces giving twelve generators.
(3) These generators are found in elevation.
(4) Generator O1 or O7 shows the true length of the generators and it is this true length that is used to draw the arc for the development.
(5) Complete the development in the usual way.

To draw the complete surface development of a truncated right cone given its plan and elevation. Fig. 11.12

(1) Like the development of the truncated pyramid Fig. 11.10 we develop the surface of the cone before it is cut.
(2) The true length of each cut generator must be found by projecting the cut end of each generator over to the side of the cone which will show it as a true length.
(3) Each length is then marked onto the development and rotated about O onto the appropriate generator.

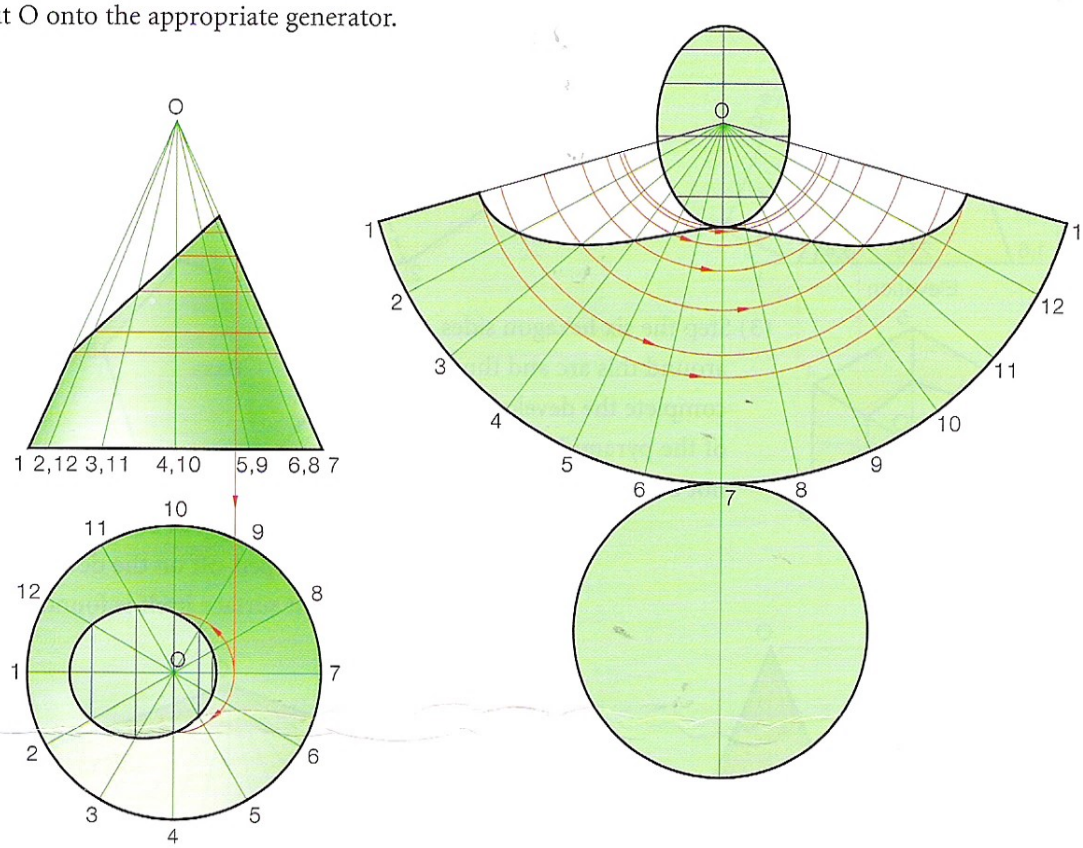


Fig. 11.12

Worked Examples

The elevation and plan of a right pentagonal prism of sides 30 mm with a Ø25 mm passing centrally through it. Draw the given views and develop the surface of the prism. Fig. 11.13

(1) Develop the prism as before.
(2) Divide the circle into 12 equal parts. Project these down to plan where the edge 3,4 is seen as a true length.
(3) w_1, w_2 and w_3 can then be transferred onto the development.
(4) Project across from the elevation to intersect perpendiculars from w_1, w_2 and w_3 and join to give a fair curve.

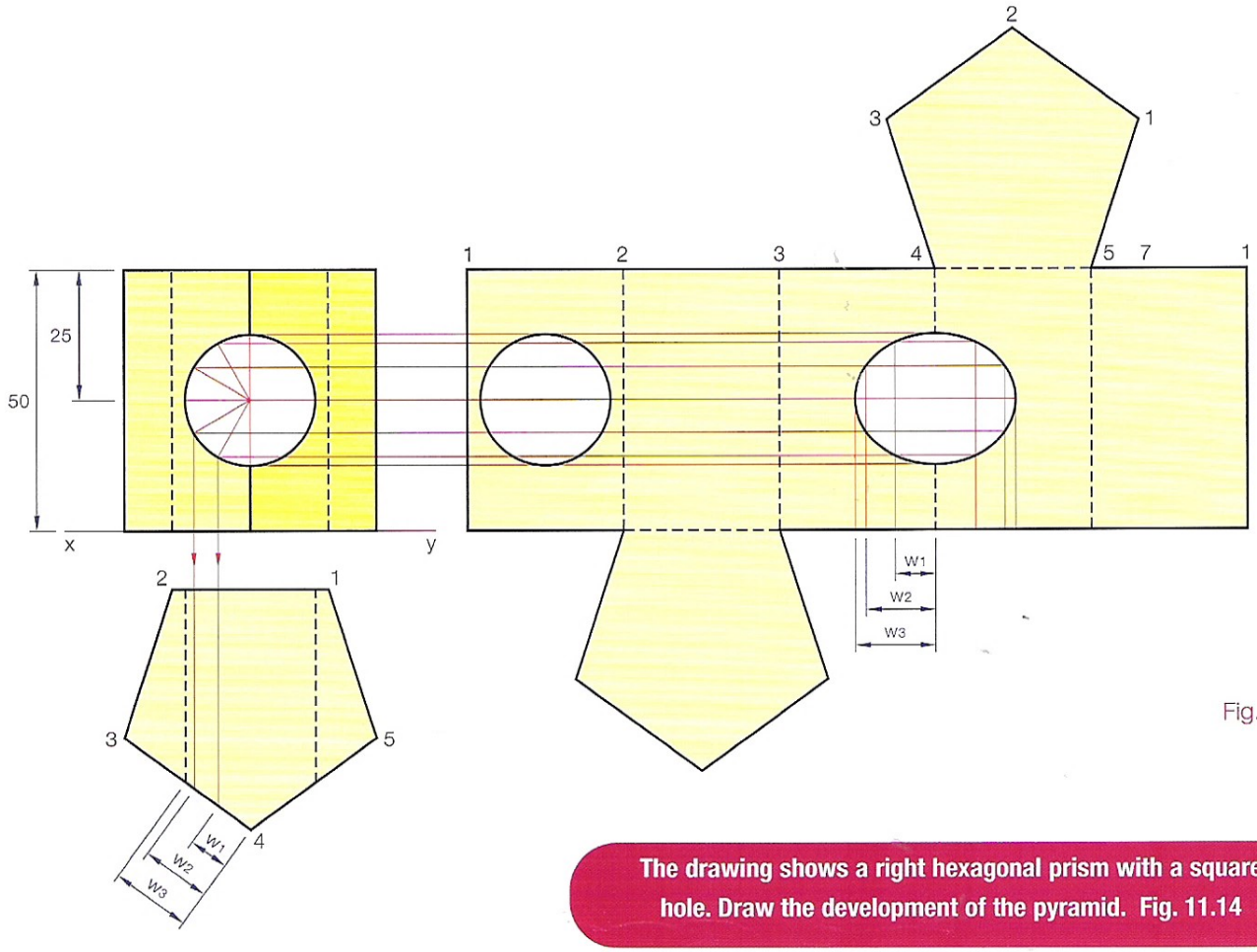


Fig. 11.13

The drawing shows a right hexagonal prism with a square hole. Draw the development of the pyramid. Fig. 11.14

(1) The square hole in plan is found by taking horizontal sections. Each horizontal section gives a hexagon in plan on which a vertex is located. The points a and b can be projected directly onto edge 1,o and 3,o. Similarly c and d are projected to edge 6,o and 4,o.

(2) Develop the surface of the pyramid. All points are brought across to edge 5,o on the elevation to find true distances.

(3) These true distances are swung around on the development and the points are located as shown. The development of the base is not shown.

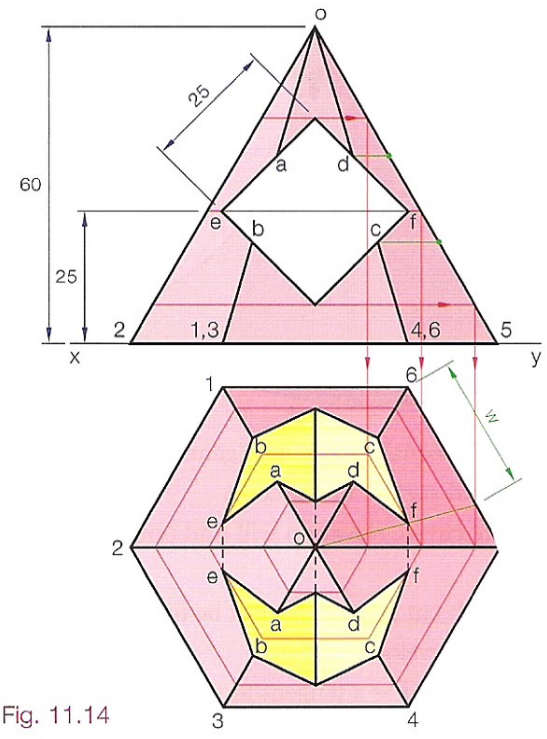


Fig. 11.14