Activities

Q1. Explain the difference between a beam and a column. Examine the types of load that each must support.

Q2. Stone was one of the few building materials available to builders in ancient times. Describe the properties of stone as a building material and then discuss how these properties affected building design during this period.

Q3. Make a neat freehand sketch of a pair of well-proportioned columns supporting a beam. The head and base of each column is to be widened in a decorative fashion.

Q4. Make a neat diagram of a cut, stone, semi-circular arch and name its parts.

Q5. Describe how the development of the arch made more 'open' building design possible.

Q6. Produce line drawings of the arches in Figures 18.7a to 18.7i.

Q7. It can be said that vaults are three-dimensional arches. Explain.

Q8. Using notes and sketches explain the difference between a barrel vault and a groined vault.

Q9. Describe how a masonry dome and a geodesic dome differ under each of the following headings:

(i) shape,
(ii) design principle,
(iii) possible size,
(iv) forces exerted on its supports.

Q10. 'Most light frame constructions depend on triangulation for their strength.' Discuss this statement and support your answer with examples.

Q11. Make neat pictorial sketches of:

(i) a conoid,
(ii) a hyperbolic paraboloid,
(iii) a hyperboloid of revolution.

Q12. Using notes and diagrams, describe the stresses on a loaded beam.

Q13. Why is stone suitable for the building of columns and yet not ideal for the construction of long beams?

Q14. For each of the following structures explain why columns are not the usual form of support:

(i) arch,
(ii) barrel vault,
(iii) dome.

Q15. Explain why reinforced concrete is an ideal material for the construction of shell structures.

Q16. Fig. 18.117 shows the outline plan and elevation of a cooling tower. It is in the form of a hyperboloid of revolution.

(i) Draw the given views.
(ii) Find the true shape of section S–S.

Scale 1:50

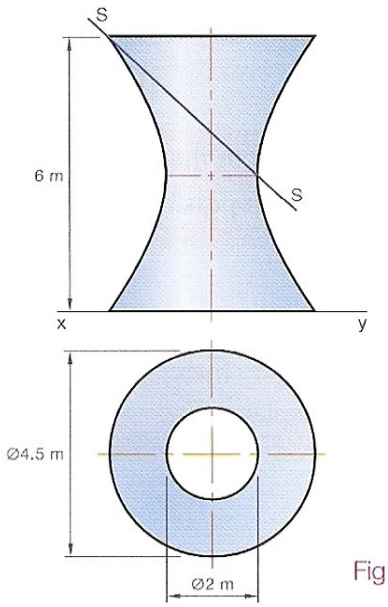

Fig. 18.117

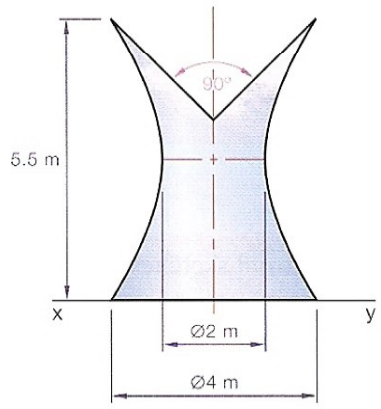

Fig. 18.118

Q17. The diagram Fig. 18.118 shows a hyperboloid of revolution which has been shaped at the top.

(i) Draw the plan and elevation of the hyperboloid.
(ii) Project an end elevation.

Scale 1:50

Q18. Fig. 18.119 shows the plan and elevation of a hyperboloid of revolution with four rib lines along its surface. Draw the given plan and elevation.

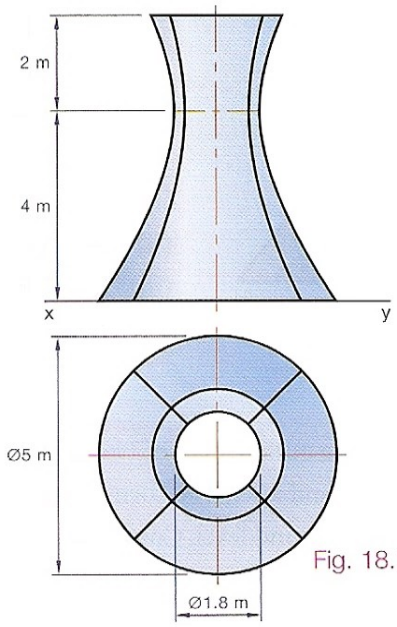

Fig. 18.119

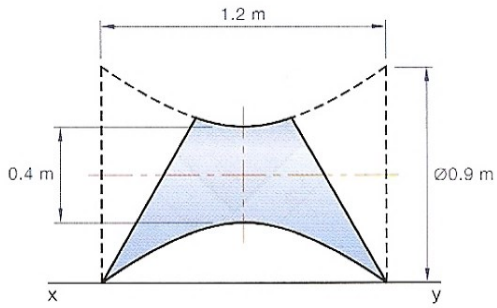

Fig. 18.120

Q19. A garden sculpture in the form of a cut hyperboloid of revolution is shown in Fig. 18.120. Draw the plan, elevation and end view of the sculpture.

Scale 1:10

Q20. Fig. 18.121 shows the outline plan of a hyperbolic paraboloid roof **ABCD**. The corners **B** and **D** are at ground level. Corner **A** is 2 m above ground level and corner **C** is 6 m above ground level.

(i) Draw the given plan and project an elevation.
(ii) Project an end view of the roof.
(iii) Find the curvature of the roof along the line joining **A** to **C**.

Scale 1:50

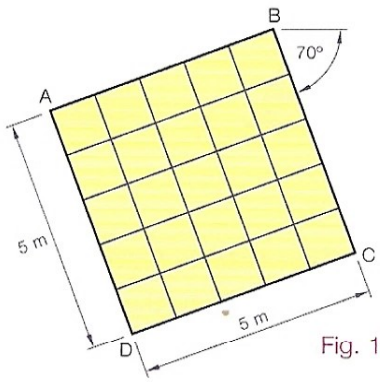

Fig. 18.121

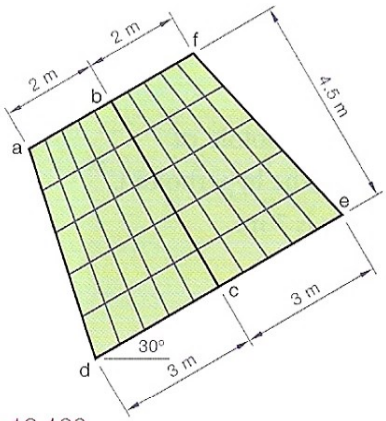

Fig. 18.122

Q21. Fig. 18.122 shows the outline plan of a hyperbolic paraboloid roof made up of two surfaces, **abcd** and **bcef**. The corners **a**, **d**, **e** and **f** are at ground level, corner **c** is 1 m above the ground and corner **b** is 5 m above the ground.

(i) Draw the given plan and project an elevation.
(ii) Project an end view of the roof.
(iii) Find the curvature of the roof along a line joining **d** and **f**.
(iv) Draw a new elevation of the roof which shows the true length of edge **dc**.

Scale 1:50

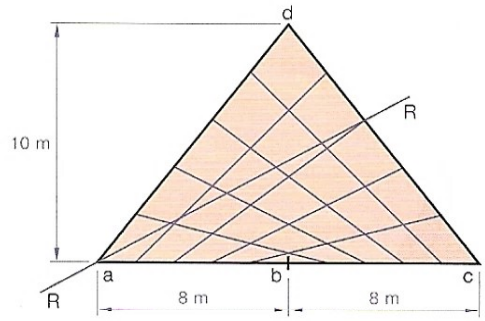

Fig. 18.123

Q22. Fig. 18.123 shows the outline plan of a hyperbolic paraboloid roof **abcd**. The corners **a** and **c** are 1 m above ground level. Corner **b** is 4 m above ground level and corner **d** is 12 m above ground level.

(i) Draw the given plan and project an elevation.

(ii) Project an end view of the roof.

(iii) Show the true shape of section **R–R** through the roof.

Scale 1:100

Q23. Fig. 18.124 shows the outline plan of two adjoining hyperbolic roof surfaces **abcd** and **abef**. The corner **a** is at ground level and corner **b** is 1 m above ground level. Corners **d** and **e** are 4 m above ground level and corners **c** and **f** are 11 m above ground level.

(i) Draw the given plan and project an elevation.

(ii) Project an end view.

(iii) Find the curvature of the roof along a line joining **c** to **f**.

Scale 1:100

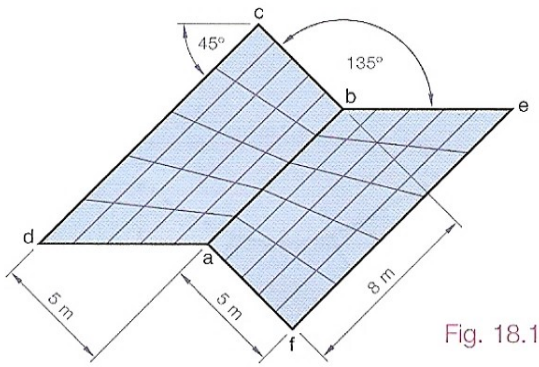

Fig. 18.124

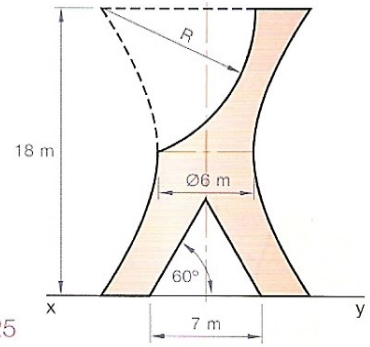

Fig. 18.125

Q24. The elevation of a hyperboloid of revolution is shown in Fig. 18.125. An equilateral triangular hole is cut through the bottom section and the top has been cut as shown.

(i) Draw the plan and elevation of the building.

(ii) Project an end view.

Scale 1:100

Q25. The elevation of a hyperboloid of revolution which has been cut is shown in Fig. 18.126. Draw the elevation, end view and plan of the cut solid.

Scale 1:100

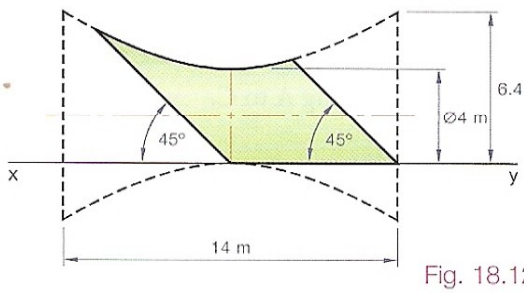

Fig. 18.126

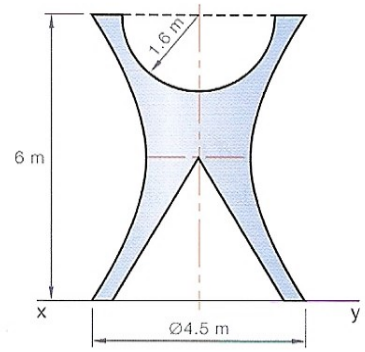

Fig. 18.127

Q26. Fig. 18.127 shows the elevation of a hyperboloid of revolution. The sides of the V-cut are elements of the hyperboloid. The true length of full length elements is 7 m.

(i) Draw the plan and elevation of the solid.

(ii) Project an end view.

Scale 1:50

HIGHER LEVEL

Q27. Given two skew line directrices of a hyperbolic paraboloid ab and cd. Also, given the traces of the plane director, determine five elements on the surface of the hyperbolic paraboloid.

a = 40, 30, 40

b = 120, 10, 10

c = 60, 10, 50

d = 130, 60, 60

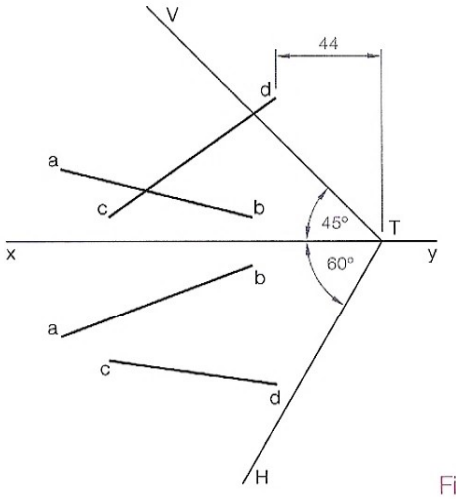

Fig. 18.128

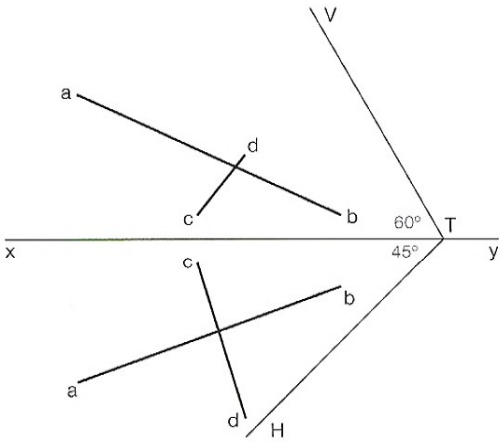

Fig. 18.129

Q28. Given two skew line directrices of a hyperbolic paraboloid ab and cd. Also, given the traces of the plane director VTH, determine five elements on the surface of the hyperbolic paraboloid.

a = 30, 60, 60

b = 140, 10, 20

c = 80, 10, 10

d = 100, 35, 75

Q29. Two skew lines ab and cd form the directrices of a hyperbolic paraboloid. The traces of the plane director for one set of elements is also given.

(i) Find the projections of five elements on the hyperbolic paraboloid.

(ii) Determine the traces of the plane director for the elements ab and cd.

a = 40, 15, 10

b = 105, 90, 100

c = 70, 70, 20

d = 130, 10, 40

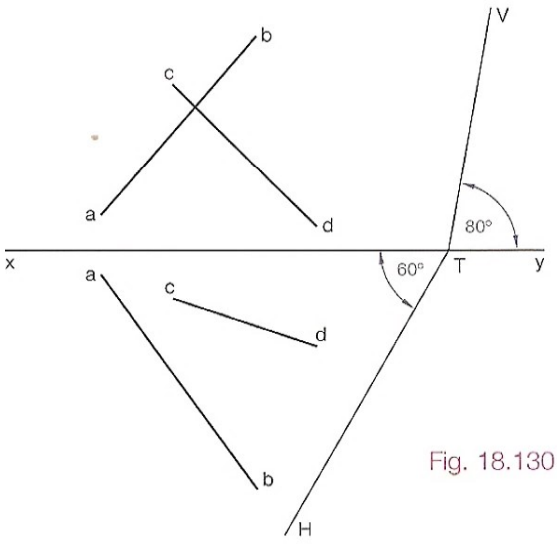

Fig. 18.130

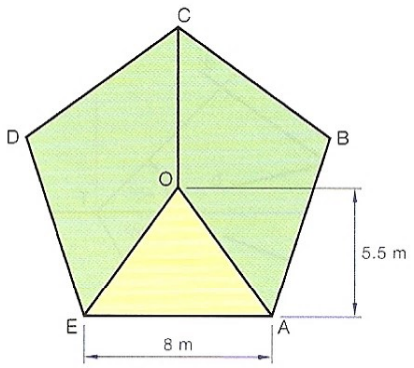

Fig. 18.131

Q30. Fig. 18.131 shows the regular pentagonal plan of two adjoining hyperbolic paraboloid roof surfaces ABCO and EDCO. The surface AEO is a plane surface. Points A and E are at ground level, D and B are 3 m above ground level, C is 5 m above the ground level and O is 10 m above ground level.

(i) Draw the given plan and project an elevation.

(ii) Show the curvature of the roof along the line CE and DO.

(iii) Determine the plane director for the edges EO and DC on the surface DCOE. Show the traces of the plane director containing the element EO.

Scale 1:100

Q31. Fig. 18.132 shows the outline plan of a roof. The semi-circular plan is an extension of the hyperbolic paraboloid surface ABCD. Lines EAB and FCB are elements of the roof with E and F at ground level. Corner B is 12 m above ground level and corner D is 15 m above ground level.

(i) Draw the plan and project the elevation.

(ii) Determine the plane director for the elements AB and CD. Show the traces of the plane director containing the element AB.

(iii) Show the curvature of the roof along the line joining D and B.

Scale 1:200

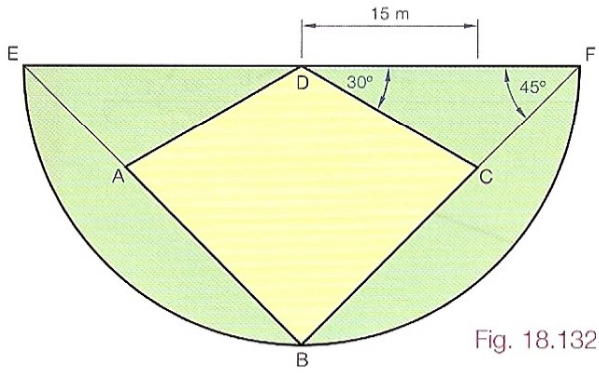

Fig. 18.132

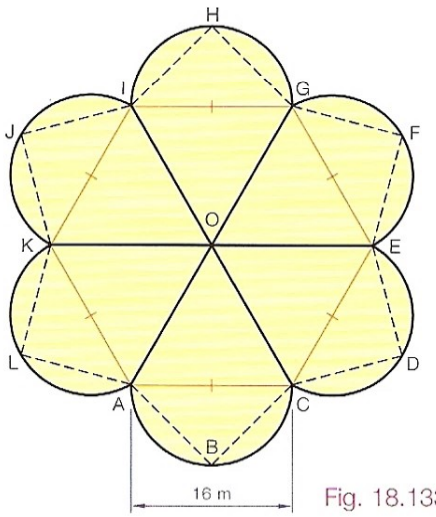

Fig. 18.133

Q32. Fig. 18.133 shows the plan of a roof which is made up from six adjoining hyperbolic paraboloid surfaces. The semicircles in plan are extensions of these surfaces.

ACEGIK forms a regular hexagon in plan.

Points **A, C, E, G, I** and **K** are 2 m above ground level. Points **B, D, F, H, J** and **L** are 10 m above ground level.

Point **O** is 16 m above ground level.

(i) Draw the plan and elevation of the surfaces **ABCO** and **CDEO**.

(ii) Show the curvature of the roof along a line joining **A** to **E**.

(iii) Determine the plane director for the edges **OC** and **AB**. Show the traces of the plane director containing the element **AB**.

Scale 1:200

Q33. Fig. 18.134 shows the outline plan of four adjoining hyperbolic paraboloid roof surfaces **ABCO**, **CDEO**, **EFGO** and **GHAO**. The full roof perimeter is a square in plan. The four surfaces have been cut as shown, to form a circle in plan. The corners **A**, **C**, **E** and **G** are at ground level, corners **B**, **D**, **F** and **H** are 10 m above ground level and corner **O** is 22 m above ground level.

(i) Draw the plan and project an elevation.

(ii) Determine the traces of the plane director for the edges **AB** and **OC** of the hyperbolic paraboloid surface **ABCO** and having its horizontal trace passing through **C**.

(iii) Find the curvature of the roof along a line joining **F** to **C**.

Scale 1:200

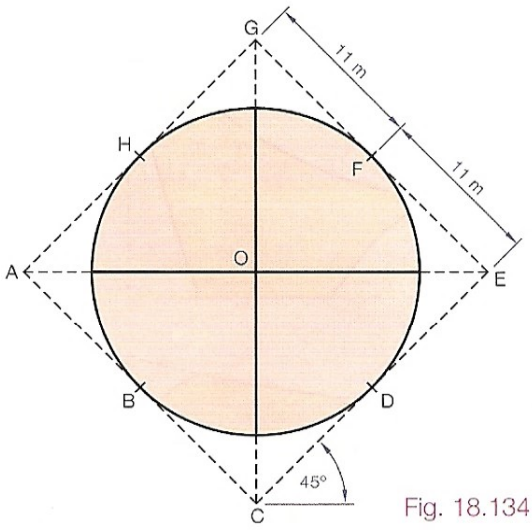

Fig. 18.134

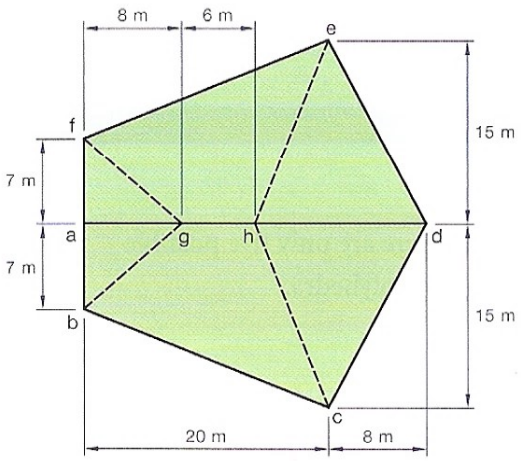

Fig. 18.135

Q34. Fig. 18.135 shows the outline plan of a roof. The roof surfaces **adef** and **adcb** are extensions of the hyperbolic paraboloid surfaces **efgh** and **bchg**. Corners **b**, **c**, **e** and **f** are at ground level, corner **a** is 18 m above ground level and corner **d** is 6 m above ground level.

(i) Draw the given plan and project a front elevation and an end elevation.

(ii) Determine the traces of the plane director for the edges **bg** and **ch** and having its horizontal trace passing through **b**.

(iii) Determine the curvature of the roof along a line from **g** to **c**.

Scale 1:200

Q35. Fig. 18.136 shows the plan and elevation of a structure which is in the form of a hyperbolic paraboloid shell. The curve DE is a parabola whose vertex is at E. The surface of the unit is generated by translating the parabola ABC in a vertical position along the parabola DE.

(i) Draw the given plan and elevation.

(ii) Project an end view.

Scale 1:500

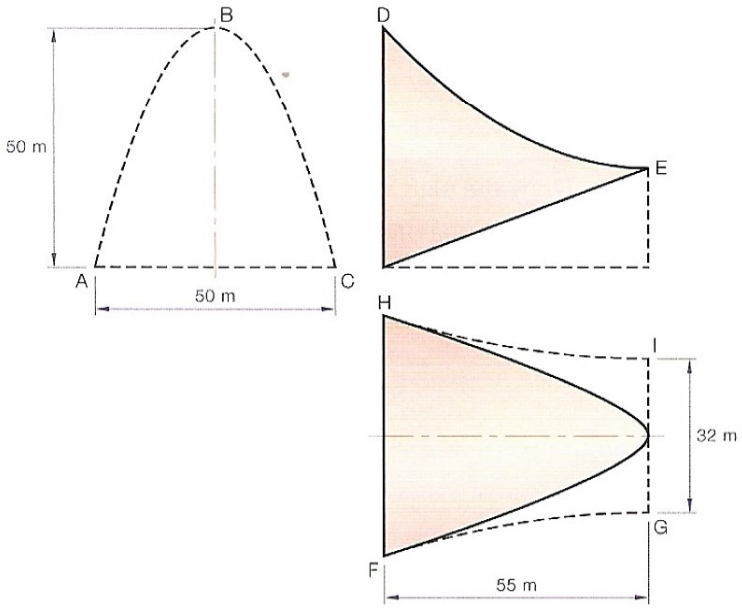

Fig. 18.136

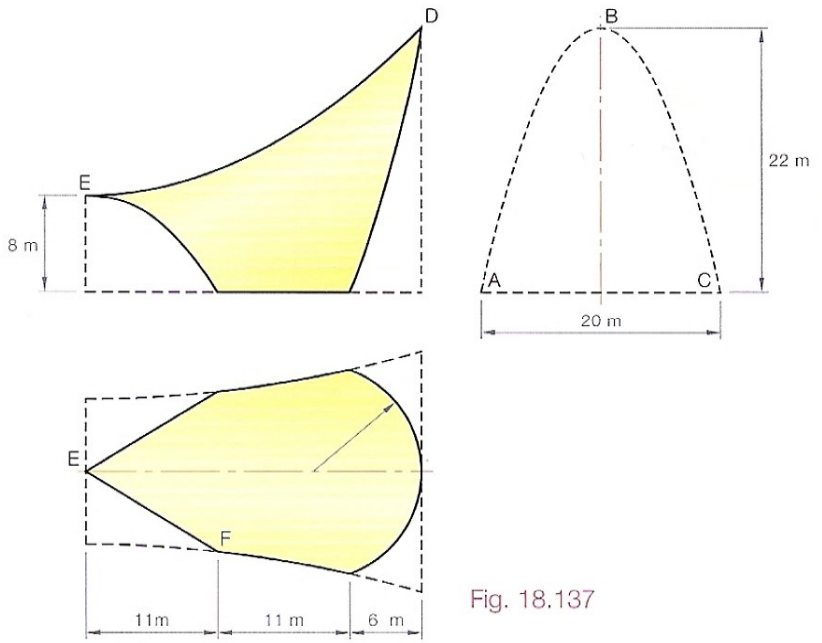

Fig. 18.137

Q36. The outline plan and elevation of a structure are shown in Fig. 18.137. The structure is generated by translating the parabola ABC in a vertical position along the parabola DE whose vertex is at E.
(i) Draw the given plan and elevation.
(ii) Project an end view.
(iii) Find the true shape of the curve EF.

HIGHER LEVEL

GEODESIC DOMES

Q37. Explain the terms:
- geodesic,
- great circle,
- lesser circle,
- regular polyhedron.

Q38. Explain why there are only five possible regular polyhedra.

Q39. Construct a tetrahedron of 90 mm side and draw its circumscribing sphere.

Q40. Draw the plan and elevation of an octahedron having one vertex on the horizontal plane and one axis vertical. The sides of the octahedron are to be 70 mm long.

Q41. Draw the plan and elevation of an octahedron having one face resting on the horizontal plane. The true length of each edge is to be 70 mm.

Q42. Draw the plan, elevation and end view of an icosahedron of 60 mm side having one vertex resting on the horizontal plane and one vertical axis.

Q43. Explain the term 'frequency' in relation to geodesic structures.

Q44. Draw the plan and elevation of a 3-frequency geodesic dome based on an octahedron of 90 mm side.