Patil S.S, Kondekar A.R / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 3, Issue 1, January -February 2013, pp.1961-1964

ANALYSIS AND DESIGN OF PYRAMIDAL ROOF SLAB BY MATLAB

PATIL S.S
Professor, Faculty of Engineering-Civil
Walchand Institute of Technology, Solapur, India
E-mail: patilss1962@gmail.com
KONDEKAR A.R
Walchand Institute of Technology, Solapur, India

Abstract:

Many historical buildings/monuments have been built having shape of a pyramid. The mystery and attractiveness of pyramidal shape have made pyramidal building undergo a renaissance in today's architectural design. Pyramidal roof slab is not a common structure because of its typical formwork and expensiveness. In countries where there is heavy snowfall, pyramidal slab is adopted so that snow can slide easily due to its sloping pattern. But in India it is constructed rarely due to less snow fall, typical form work, requirement of skilled labor and its expensiveness. A roof/slab consisting of a plane surface triangular in shape and bounded on each side by a sloping ridge forming the intersection of adjacent planes and culminating in a common vertex is known as pyramidal roof. Triangular panels of pyramidal slabs make an angle with vertical axis. According to that angle effect of thrusts and moments is decided. There are two types of moments: i) Along the slope ii) Across the slope depending upon the boundary conditions. The primary aim of the work is to analyze and design the Pyramidal roof slab. Different boundary conditions are considered like Pyramidal panels (a) with and without ridge beam (b) with and without edge beam (c) supported on wall and (d) supported on columns with different conditions. Primary thrust, Secondary thrust, Moments in different direction as well as at the edges and ridges are determined. As per that Design is carried out using Limit State Method. Analysis is also checked using MATLAB.

Keyword: Pyramidal roof slab

I. INTRODUCTION

Slabs are plate elements having the depth D much smaller than its span and width. They usually carry a uniformly distributed load from the floor or roof of the building. Like beams, slabs are also simply supported, cantilever or continuous. The slabs are classified as:

Planar roof slab

The planar roof slabs are further classified as follows:

1. One way slab
2. Two way slab
3. Flat slab supported directly on columns without beams.
4. Waffle slab / grid slab
5. Circular slab

Non-planer roof slab:

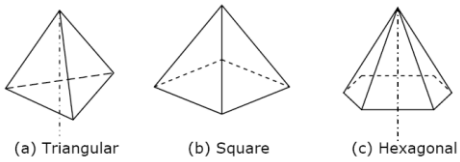
1. Domes (concrete shell roofs)
2. folded plates
3. **Pyramidal roof slab**
4. Arch ribs
5. Long cylindrical shell

A roof / slab consisting of a plane surfaces triangular in shape and bounded on each side by a sloping ridge forming the intersection of adjacent planes and culminating in a common vertex is known as pyramidal roof. Many historical buildings/monuments have been built in shape of a pyramid. The CHEOPS pyramid in Egypt is one of the Seven Wonders of the World. Today no one can give an exhaustive account of the reasons why a tomb was constructed as such a giant regularly shaped monument. How was it built? What techniques did the builders use?

Pyramidal roof slab is not a common structure because of its typical formwork and expensiveness. Earlier it was not used much but now a day the trend is developed. In countries where there is heavy snowfall, pyramidal slab is adopted so that snow can slide easily due to its sloping pattern. But in India it is adopted rarely due to less snow fall, typical form work, requirement of skilled labor and its expensiveness. Behavior of pyramidal slab is not like one-way or two-way slab. In case of **one way and two way slab** bending moment along effective span is pre-dominant and according to that steel is provided in either direction. In normal cases the shear in slab is not critical.

In case of pyramidal slabs, triangular panels make an angle with vertical axis. According to that angle effect of thrusts and moments decided. There are two types of moments: i) in panel, ii) at the edges according to the support given to them. Different types of

triangular pyramid are shown below.



Different types of pyramidal roof slab

A section which cuts each ridge at the same distance from vertex is a normal cross section; in general, a regular figure whose normal cross section has axis of Symmetry at right angles to one another is desirable in this form of construction. Therefore five or seven sided panel pyramids are avoided. They are often limited to four sides. The axis of pyramid may be defined as the line passing through the centre of all cross sections and the vertex. This axis should be vertical. For the investigation of the forces in the pyramid as detailed below can be considered:

1. (a) Pyramidal panels without beams at ridges and edges and resting on wall.

(b) Pyramidal panels with edge beam but without ridge beam and resting on wall.

2. (a) Pyramidal panels with ridge beam but without edge beam and resting on wall.

(b) Pyramidal panels with ridge beam and with edge beam and resting on wall.

3 (a) Pyramidal panels with ridge beam without edge beam with and resting on columns at corner.

(b) Pyramidal panels with ridge beam and edge beam with and resting on columns at corner.

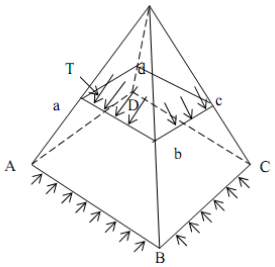
II. OBJECTIVE OF STUDY

The project aims at Analysis and Design of Pyramidal slab as per standard provisions. Limit state method is used for analysis and design. . The project also consists of cross check of manual results with the.

1. Detailed understanding of Pyramidal slab.
2. Detailed analysis and design as per Indian standards.
3. To compare manual results of analysis with software results.
4. To carry out parametric study of forces and moments of pyramidal slab, edge beam and ridge beam with the variation in height, thickness, base dimension and base angle.

III. ANALYSIS OF FORCES AND MOMENT

Pyramidal roof consists of pyramidal panels without beams at the ridges and edges. In this type, equal triangular faces are supported by the sloping edges of the other faces as shown in fig.2 The pyramid so formed will remain in position because it is prevented from sliding outwards by giving them support at lower edges by wall.



Pyramidal panels without beams at ridges and edges

- **Moment**

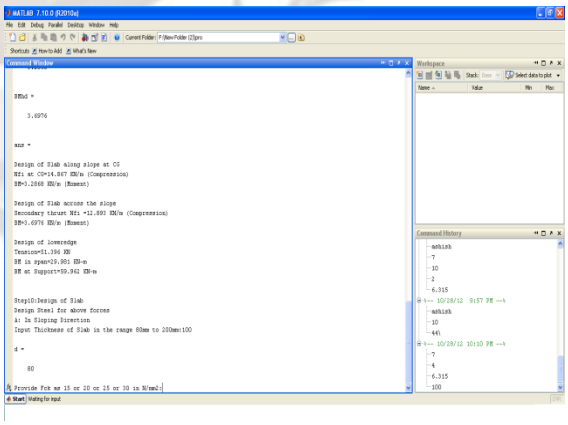
. Bending of triangular panel occurs due to the loads acting normal to their surfaces. Panels of the pyramid must have stiffness & be capable of resisting bending & thrust. If the structure If the structure is framed by means of beams at the ridges and lower edges it has to resists bending. In case of unframed structures importance of the bending stresses and thrusts depends on the inclination of the sides with horizontal. When the panels are almost vertical the bending effect is small and direct s is predominant.

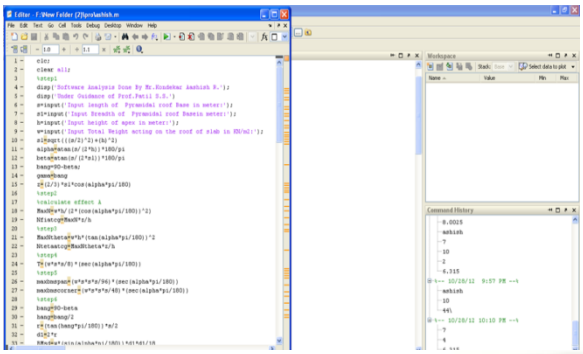
To know about the bending pattern of triangular panel consider the contours of equal deflection in panels of varying proportions. Consider three types of triangular panel.

a) Acute angled triangle
b) Equilateral triangle
c) Obtuse angled triangle

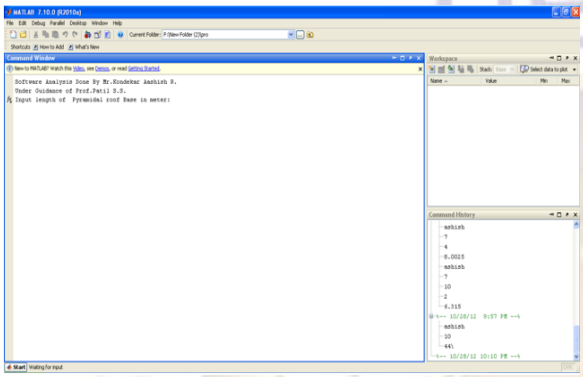
IV. USING MATLAB:

1) First Coding Required

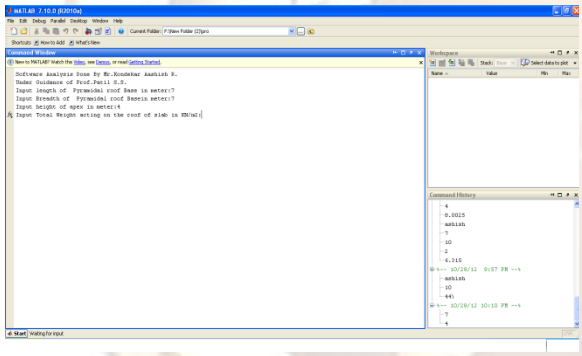




2) Take dimensions:



3) Take Loading:



4) After loading enter the button & give the result

V. COMPARISON OF THREE CASES

	Case 1 Panel unconnected at ridges	Case 2 Panels connected at ridges & supported vertically at the edges	Case 3 Panels connected at ridges & supported at corners
Meridional thrust (T)	$T=\frac{1}{2}wy\frac{1}{\cos^2\alpha}$	$T=\frac{1}{2}wy\frac{1}{\cos^2\alpha}$	$T=\frac{1}{2}wy\frac{1}{\cos^2\alpha}$
Secondary Thrust (H)	$H=wy\tan^2\alpha$	$H=wy\tan^2\alpha$	$H=wy\tan^2\alpha$
Moment			
In Sloping Direction	$Ms=w\sin\alpha\frac{d^2}{18}$	$Ms=w\sin\alpha\frac{d^2}{18}$	$\frac{w}{3}y^2\tan^2\alpha\sin\alpha$
In Horizontal Direction	$Mh=w\sin\alpha\frac{d^2}{16}$	$Mh=w\sin\alpha\frac{d^2}{16}$	
Forces at lower edges			
Tension	Restrained in both direction so no moment in lower edges	$P=\frac{w}{8}S^2\sec\alpha$	$P=\frac{w}{8}S^2\sec\alpha$
Moment in the span		$M_{span}=\frac{w}{96}S^3\sec\alpha$	$M_{span}=\frac{w}{96}S^3\sec\alpha$
Moment at the corners		$Mc=\frac{w}{48}S^3\sec\alpha$	$Mc=\frac{w}{48}S^3\sec\alpha$
Shear force			$R=\frac{TAB}{2\cos\beta}$

VI. COMPARISION BETWEEN LIMIT STATE METHOD AND MATLAB

	Limit State	MATLAB	Remark
a	7	7	
b	7	7	
h	4	4	
t	0.1	0.1	
T	14.989	15.01	Nearly same
H	12.555	13.02	Nearly same
Ms	3.3	3.32	Nearly same
Mh	3.7	3.73	Nearly same

VII. CONCLUSION

- The thickness of the slab is considered between 100mm to 150mm. Stresses in slab; moment and tension in edge beam are within permissible limit. Axial force, shear force and moment in ridge beam are also increase with the increase in thickness.
- If the span/height ratio is within 1.75 to 2.3 than stresses and moment in slab; tension, moment, axial force in edge beam and ridge beam are also decrease as the height increases.
- As the base angle increases
    1. Stresses and moment in pyramidal slab will decrease
    2. Shear force and bending moment in edge beam will decrease
    3. Axial force, shear force and moment in ridge beam will increase.
-

REFERANCES

1) M. Ikhwan, B.Ruck, Flow and Pressure field characteristics around Pyramidal buildings, Journal of Wind Engineering and Industrial Aerodynamics 94 (2006) 745 765.
2) Richard Bradshaw, David Campbell, Mousa Gargari, Amir Mirmiran, and Patrick Tripeny (2002).
3) J.Terrington, Design of Non Planer roof, (1964).
4) P.C. Varghese “Design of Reinforced concrete shells and Folded Plates”.
5) G.S.Ramaswamy, Design and Construction of Concrete Shell Roof - First Edition, Delhi 1986.
6) N.K.Bairagi, Plate Analysis, First Edition-Delhi, 1986.
7) H.J.Shah Reinforced Concrete.