

Staircase Normal

Suyash Agrawal
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1 INTRODUCTION

In this experiment we try to measure the surface normal of the staircase near Mathematics building in IIT Delhi. For this we have thought of two methods:

- Using the image of absolute conic in image
- Using orthographic geometry

2 USING IMAGE OF ABSOLUTE CONIC

Image of absolute conic can be found in image using various perpendicular lines along three different planes. This can be done because the CSC building is rectangular and we will easily be able to find sets of parallel and perpendicular lines.

After finding the image of absolute conic ω and thus ω^* ($= \omega^{-1}$). We can find the vanishing lines of the top plane of roof and the inclined plane using two sets of parallel lines for each. Let us call them l_1, l_2 . After finding them we can find the angle between the two planes as:

$$\cos\theta = \frac{l_1^T \omega^* l_2}{\sqrt{l_1^T \omega^* l_1} \sqrt{l_2^T \omega^* l_2}}$$

Now, we find the angle of the inclined plane from two perpendicular planes (e.g. road and the side of CSC building) and then we can easily find the normal of plane after getting the angles.

3 USING ORTHOGRAPHIC PROJECTION

For orthographic projection, we make use of two images. One is taken from the view of blocks and other from the view of library. The images are metric corrected to approximate orthographic projection as close as possible. We then find the angles β and θ as shown in the figure.

Now, we try to find the angles α (angle from top view) and γ (inclination of plane). l can be decomposed along coordinate axis as:

$$l = (l\cos\gamma\sin\alpha, l\cos\gamma\cos\alpha, l\sin\gamma)$$

Therefore:

$$\tan\beta = \frac{\tan\gamma}{\sin\alpha}, \tan\theta = \frac{\tan\gamma}{\cos\alpha}$$

Knowing, β and θ , we solve for the angles α and γ .

Now, the normal of the inclined plane is:

$$n = (\sin\gamma\sin\alpha, \sin\gamma\cos\alpha, -\cos\gamma)$$

Angle definitions:

- α : Angle of l with normal to the front of csc building in top view
- β : Angle of l with top of maths building in front view
- γ : Actual angle of inclined plane with the plane of the top of maths building
- θ : Angle of l with the top of maths building in the view from library

The normal found here is w.r.t to the point O as shown in the figure.

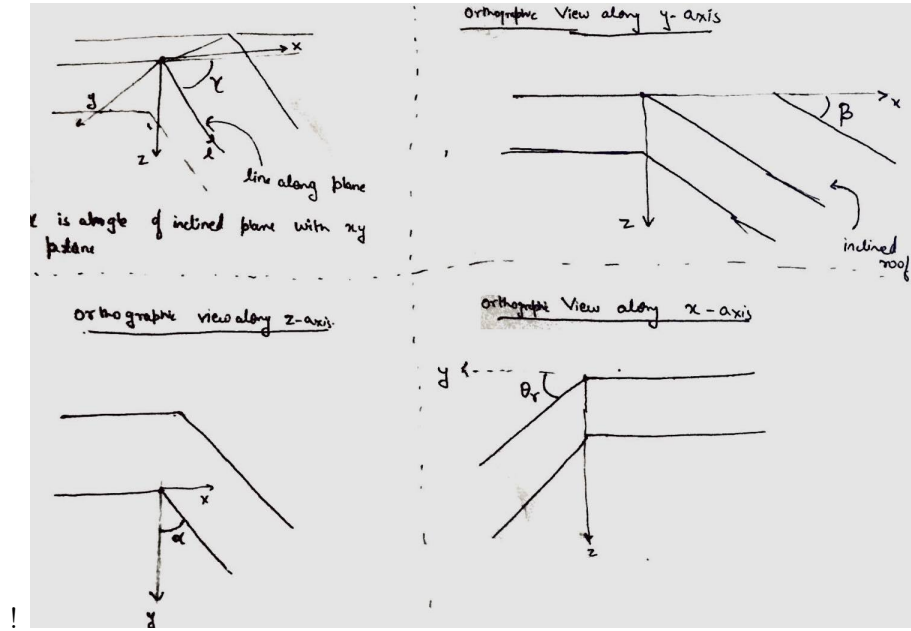


Figure 1: Diagram

4 RESULTS

We obtained the following results using the orthographic projection method:

- $\beta = 19.17^\circ$
- $\theta = 8.85^\circ$
- $\alpha = 24.13^\circ$
- $\gamma = 8.08^\circ$
- $n = [0.058, 0.128, -0.99]$

The plane has an inclination of 8° from top of building.

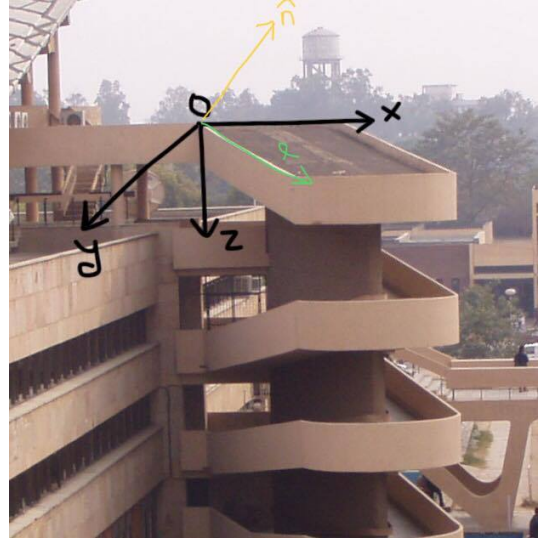
DECLARATION OF ORIGINALITY

I hereby claim that the work presented here is my own and not copied from anywhere. Though, the ideas for the method were discussed among the following peers: Aman Agrawal (2015CS10210), Ankesh Gupta (2015CS10435) and Saket Dingliwal (2015CS10254), Krunal Shah (2015EE10476).

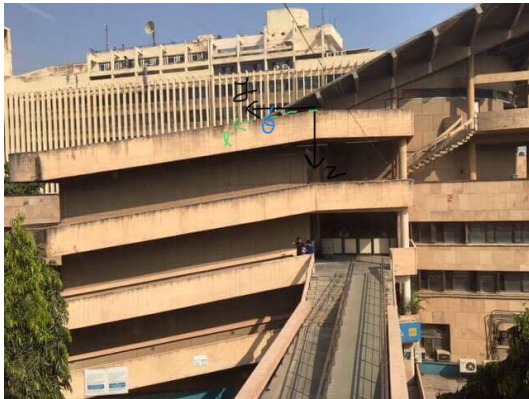
The code that I wrote for the whole process was solely my own.



(a) Staircase



(b) Coordinate Axis



(c) Library view



(d) Block view

Figure 2: Various views used



(a) Metric Corrected library image



(b) Metric corrected block image

Figure 3: Metric correction for the images