

*Research Paper*

DETERMINATION OF TRAJECTORY OF MATERIAL LEAVING THE BELT CONVEYOR BY THE MS-EXCEL PROGRAM AND TRANSPORTING CORRESPONDING COORDINATES TO CADIAN/AUTOCAD SOFTWARE WINDOW

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For design of discharge openings and receiving chutes, it is necessary to know the trajectory of material leaving the head pulley in a conveyor system. Trajectory of material is fixed by the angle of separation of material from the belt and the vertical ordinates from the tangent line drawn at the point of separation on head pulley. This program is for plotting the “Material Discharge Trajectories” for any Belt-Conveyor system viz., Horizontal/Incline/Decline Belt Conveyors. This program has been developed on MS-Excel platform and its output is available for use in drafting software like CADIAN/AUTOCAD, etc.

Keywords: Belt conveyor, CADIAN/AUTOCAD, MS-EXCEL, Pulley, Trajectory

INTRODUCTION

The following procedure has been extensively in use for plotting of the material discharge trajectories.

DETERMINATION OF POINT OF SEPARATION

The angle of separation, that is, the angle from vertical at which material will leave the belt as it travels over discharge pulley is calculated from the following formula:

$$\cos \theta = V^2 / (g \cdot r_p) \quad \dots(1)$$

where

V = Belt Speed (m/s)

r_p = Radius of the pulley (m)

DETERMINATION OF ORDINATES

The length of vertical ordinates h_1 , h_2 , from point at equal intervals placed on tangent line drawn at the point of separation are calculated from the following formula:

$$h_1 = g t_1^2 / (2 V^2), \quad h_2 = g t_2^2 / (2 V^2)$$

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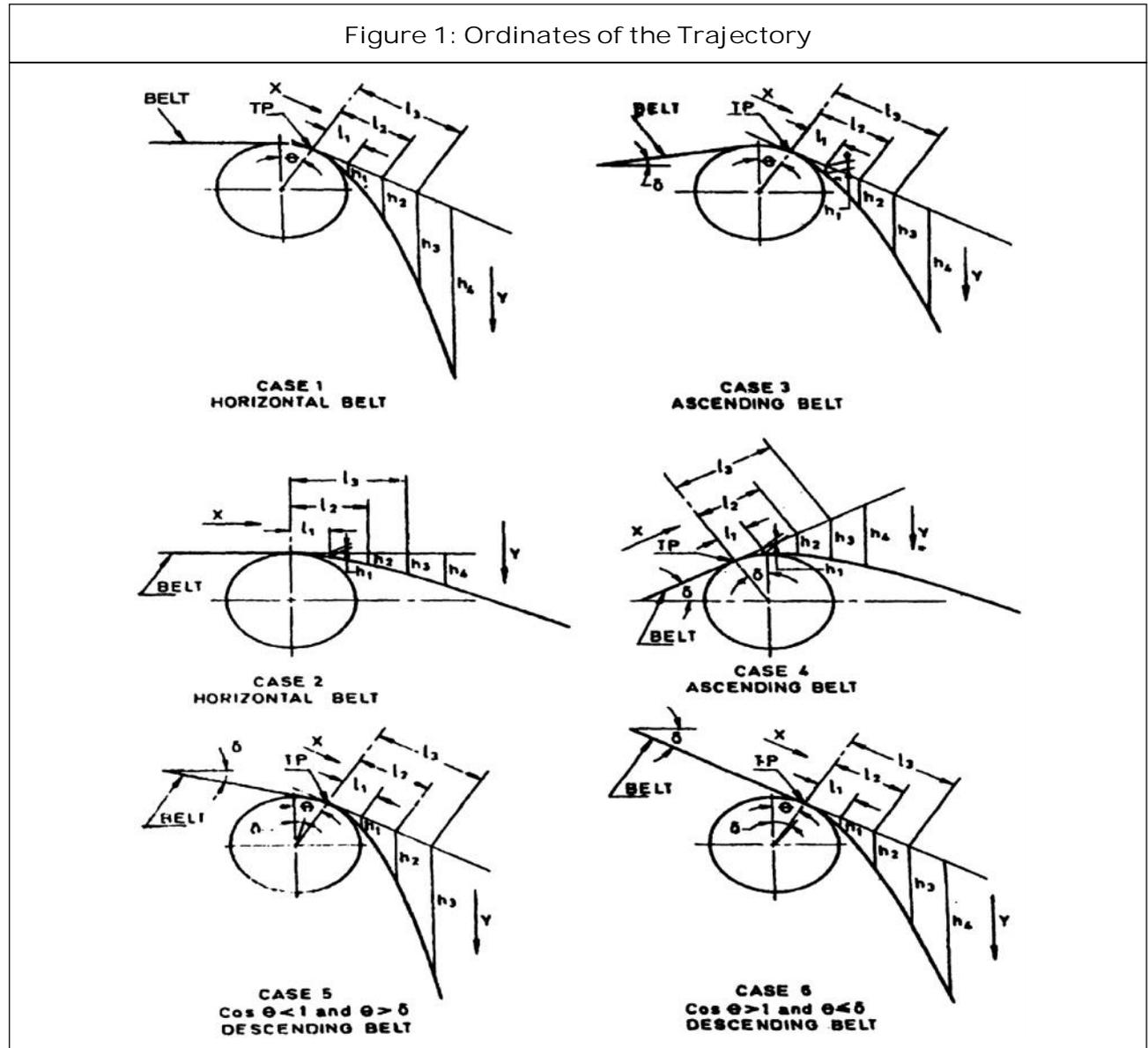
For guidance the value of ordinates h_1, h_2 , in metres with $l = 0.50$ m per 1.0 m/s of belt speed are given below:

Table 1: xxxxxxxxxxxxxxxx				
h1	h2	h3	h4	h5
0.012	0.049	0.110	0.196	0.306
h6	h7	h8	h9	h10
0.441	0.600	0.784	0.993	1.226
h11	h12	h13	h14	h15
1.483	1.765	2.071	2.402	2.757

GRAPHICAL REPRESENTATION OF TRAJECTORY OF MATERIAL

The graphical representation of trajectory of material indicates the actual path which will be followed by the material after it leaves the discharge pulley. The trajectory of the material depends upon the configuration of the belt conveyor and is graphically represented in the manner laid down in A and B.

Figure 1: Ordinates of the Trajectory



For Ascending and Horizontal Belts
 If $\cos \theta < 1$ then the tangent line shall be drawn at the point of separation (see Figure 1). If $\cos \theta = 1$, the tangent line shall be drawn in the direction of belt travel (see Figure 1).

For Descending Belts

If $\cos \theta < 1$ and angle of separation is more than angle of inclination, α , of the conveyor belt then the tangent line is drawn at the point of separation (see Figure 1). If $\cos \theta \geq 1$ and is less than or equal to angle of inclination, α , of conveyor belt, the tangent line shall be drawn in the direction of belt travel (see Figure 1).

For drawing the trajectory of top of the stream of material of height H_1 , the radius r_p in formula (1) is replaced by $(r_p + H_1)$ and velocity V by:

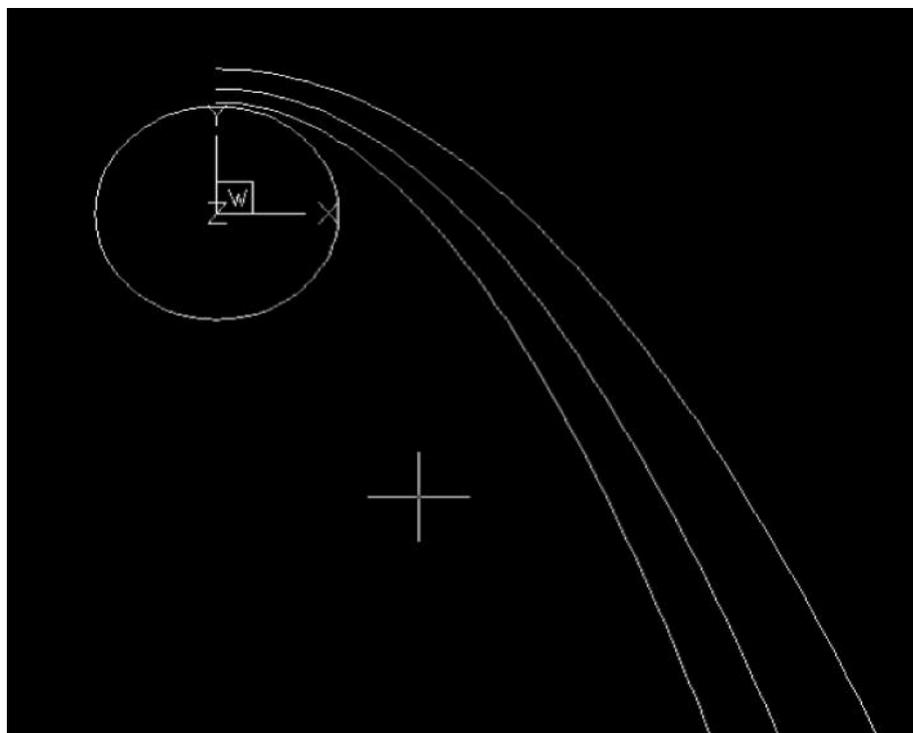
$$V \cdot (r_p + H_1) / r_p$$

With centre of pulley as the origin of the XY-Coordinate system, forming algebraic equations for each possible case of the trajectory (Parabolic Path) and using MS-Excel platform many coordinates representing the trajectory are derived.

Transporting XY-Coordinates of the Trajectory to CADI AN/AUTOCAD Software

1. XY-coordinates of the trajectory with centre of pulley as O (0, 0) will be shown on the sheet named "autocad". Save this as CSV (Comma delimited) file. Open this. CSV file with notepad and write in the first line PLINE and then press enter once. Then save this notepad file as SCRIPT FILE (SCR). Just drag this SCRIPT file over the window of the DRAFTING SOFTWARE and will get the plot of a trajectory required.

Figure 2: Trajectory of the Material (in CADI AN/AUTOCAD)



2. Explode this transported figure and delete two straight lines. Then draw circle with centre O (0, 0, 0) representing the pulley of the specified radius and making block of the same entire figure could be shifted to any place in the window of the drafting software.
3. Finally the plot of the trajectory would be as shown in the Figure 2.
4. If discharge pulley is on the left hand side of the conveyor system, then the mirror image of the above plot can be utilized.

CONCLUSION

The Coordinates as Obtained from the program and calculated manually are in close agreements. Using this program, industry can save many man hours with increased accuracy of the plot and thereby have huge cost reduction in the design process of conveyor system. 🌀

REFERENCES

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2. *Material Handling Engineers Association*, 1986.