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Design and development of Slat Conveyor for Bagasse Handling

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Abstract:
A conveyor system is a common piece of material handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Bagasse is the fibrous matter that remains after sugarcane are crushed to extract their juice. It is currently used as a bio-fuel and in the manufacture of pulp and building materials. Over past many years, changes had to be made to chain slat conveyors to accommodate the much higher tonnages and to improve performance. Slats are the key components of any slat conveyor. Therefore to obtain better performance of slat conveyor, different theoretical cases have been studied by changing angle of slat, by changing height of slat.

Keywords*: Slat conveyor, Design, Development, Slat*

1. Introduction

Modern civilization requires handling of bulk materials in huge quantity. Our present civilization aims at producing innumerable items for utility and comfort of human race. All these items are produced from raw material from our unique planet with appropriate / modification.

The bulk materials need installation of special bulk material handling system at source of raw materials , and also at process (consumption) unit. The raw materials being mined has to be temporarily stored in gigantic piles , to be retrieved on need and to be loaded in to railway – wagons / trucks. When such material arrived at cement /steel /power plant , some are to be unloaded ,stored, retrieved and finally to be consumed for making end product. Again , if the end product is a new bulk material ,it will be further handling for storage, reclamation and onward transport.

The bulk material handling system consists of numerous equipments, which work in co-ordinated pre planned manner to achieve functional need. The slat conveyors are very preeminent and important equipment in such system, to ensure flow of material through various parts of the system.

2. The Slat Conveyor

Conveyor system is a mechanical system used in moving materials from one place to another and finds application in most processing and manufacturing industries such as: chemical, mechanical, automotive, mineral, pharmaceutical, electronics etc. There are various types of conveyor systems available such as gravity roller conveyor, belt conveyor, slat conveyor, bucket conveyor ,flexible conveyor ,belt driven live roller conveyor, chain conveyor , etc . The choice however depends on the volume to be transported, speed of transportation, size and weight of materials to be transported, height or distance of transportation, nature of material, method of production employed. Material handling equipment ranges from those that are operated manually to semi-automatic systems and to the ones with high degree of automation. The degree of automation however depends on handling requirements.

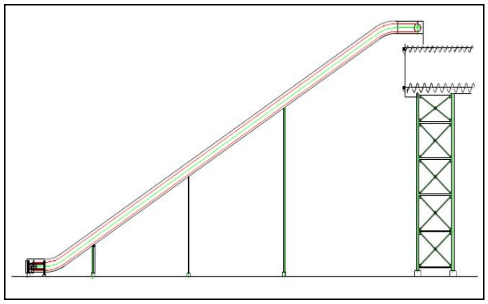
Material handling involves movement of material in a manufacturing section. It includes loading, moving and unloading of materials from one stage of manufacturing process to another.

A slat conveyor has the open links of chain drag material along the bottom of hard faced MS (mild steel) or SS (stainless steel) trough. The trough is fixed and slats are movable. The slats are the mechanical components that fixed between two strands of chain which drags the material from feeding end to the discharge end. These slats are available in different widths and lengths as per the site requirements. A small gap is made purposely between slats and trough. The slat conveyors are designed for horizontal and inclined transport of sawdust, chips, bagasse and other bulk goods. Slat conveyors are the traditional and most common means for distributing bagasse to boilers.

2.1. Input parameters required for development of slat conveyor

While designing a slat conveyor only four input parameters will be given by customer which are as follows-

- Guaranteed capacity = 33mtph
- Conveyor Length = 43.4 m
- Conveyor lift = 19.5 m
- Material to be handled = Bagasse (Density= 150Kg/m^3)
- Conveyor inclination = 31^0



3. Numerical Analysis for Different Configurations

In slat conveyor number of components are used like slat, trough, chain, chain resting part, roller ,pin ,Sprocket, drive shaft, tail shaft, gear box, motor, etc. We have to design some of these components while using these components in system.

The two main requirements in the design of the conveyor are the ability to convey all the bagasse from the final mill and sufficient strength in all parts to withstand any expected working stresses. To meet these requirements, from previous experience we fixed the-

- speed of conveyor =0.4 m/sec
- width of flights =1.5 m
- Height of slight =275 mm
- spacing of flights = 0.8 m

Also we know that , Density of material =150 kg /m ^{3}

First of all, we will calculate the the cross sectional area of bagasse on conveyor for two cases-

- When conveyor is horizontal.
- When conveyor is inclined.

When slat conveyor is horizontal maximum bagasse will be occupied between the two slats. But when conveyor will become inclined then in such case the bagasse will fall down above its surcharge level. So we will design the conveyor for the case when slat conveyor is inclined.

At angle of slat is 90° :

i) When conveyor is horizontal.

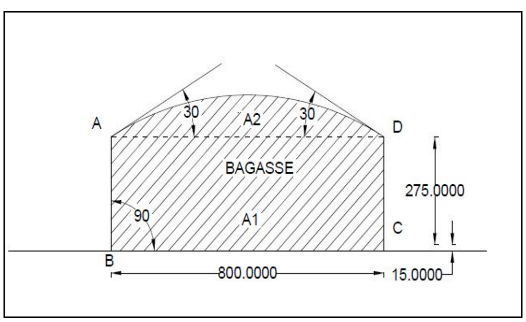


Figure 3.1: Cross-section of bagasse on horizontal conveyor

Material cross section on slat conveyor:

The material cross section on conveyor is formed by the trough profile on bottom side, and by surcharge angle for curved top. The experience shows that the material being carried on slat conveyor will have cross section as shown in figure.

The area is made up of two parts viz.A1 and A2 .The area A1 is known as water level fill area. The area A2 above water fill is known as top area. The water fill area A1 shape and magnitude is fixed by trough profile/shape. Regarding shape of top area A2, ISO considers it to be arc of parabola where as USA practice considers it to be an arc ends are inclined at surcharge angle α. It is obvious that the water fill area A1 is same for both the shape of arc. This topic explains the derivation of total cross section area A1+A2 with parabolic arc and also with circular arc. The derivation also includes the calculation of material height on conveyor.

Since we know that, height of slat is 275 mm i.e.0.275 m and their spacing between slat and trough is 15 mm i.e.0.015 m.

So the total height of slat will become 290 mm i.e.0.290 m.

i)When conveyor is inclined at 31^0:

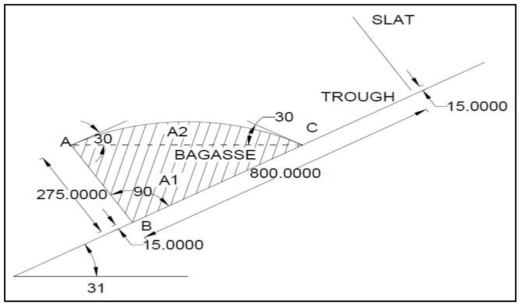


Figure 3.2: Cross-section of bagasse on inclined conveyor

Let,α = surcharge angle

=30° (For bagasse ,surcharge angle =30^0)

In ΔABC ,

Sin31= $\frac{AB}{AC}$

Therefore, AC = 0.563065 m

And, tan31= $\frac{AB}{BC}$

Therefore, BC = 0.482641 m

Now, Water fill area,

i.e. A(ΔABC) = A1

= $\frac{1}{2}$ * BC * AB

A(ΔABC) = 0.0700 m^2

Top area of parabola,

$A_2 = \frac{1}{6} * L^2 * \tan\alpha$

Here, L= Base= AC=0.563065 m

A_2 = 0.0305 m^2

Therefore, Total area = A_1+A_2

=0.100488 m^2

The total cross sectional area of bagasse is 0.100488 m^2 when slat angle is 90^0.

Design calculations:

Gauranted capacity : 33mtph

Design capacity : 38mtph

Conveyor length : 43.4 m

Conveyor lift : 19.5 m

Material handled : Bagasse (Density= 150Kg/m^3)

Lump size=-100 mm

Flight size = 275*1500mm wide

Flight spacing = 800 mm

Flight Thickness = 6 mm

Flight material= M.S. (Mild Steel, Density =7850Kg/m^3)

∵ We know that ,Flight mass = Flight volume *flight material density

∴ Flight mass = (0.275*1.5*0.006) *7850

∴ =19.428750 Kg.

As the spacing between two slats is 0.8 m.

∴ Flight mass per meter = $\frac{(0.275*1.5*0.006*7850)}{0.8}$

∴ Flight mass per meter =24.28594 Kg.

Material carrying run = Material is conveyed in forward motion.

Type of casing= Independent enclosed casing for forward run and return run.

Lift for forward run =19.5 m

Conveying capacity for forward run =33 mtph (Gauranted)

38 mtph (Design)

Material conveyed upper run = Fresh (wet) bagasse ; 150Kg/m^3 ;50% moisture.

Chain arrangement= double strand ; Each strand of 30 Kg/m ; two strands ;total 60 Kg/m,200 mm pitch ; 80 tonn Breaking load.
Chain mass per meter =30*2= 60Kg
Chain and flight travel speed =0.4 m/sec (24 m/min)
Chain pin diameter = 28 mm
Chain Roller diameter =75 mm
Type of motion for Chain and Flight =Rolling trough chain and rollers.
Type of motion for Bagasse =Dragging by Flights in bottom portion of casing.

Capacity calculation:

The total cross sectional area of bagasse is 0.100488 m^2.
∴ Volume of bagasse per slat /flight = (0.100488 *1.5) m^3.
∴ Mass of bagasse per slat /flight = (0.100488 *1.5*150) Kg.
=22.6098 Kg.
But spacing between two slats is 0.8 m.
∴ Mass of bagasse per meter = $\frac{(0.100488*1.5*150)}{0.8}$ Kg/m.
=28.26225 Kg/m.

Material height in upper run:

∵ We know that, Mass of bagasse per meter =28.26225 Kg/m.
We are considering that this mass of bagasse is spreaded uniformly over unit length.

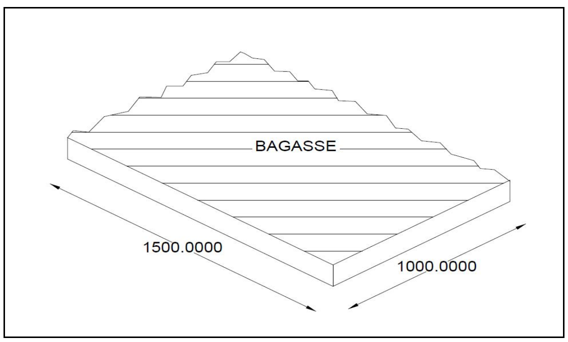


Figure 3.3: Height of bagasse layer

Therefore, Mass of bagasse =Length of layer *Width of layer *Height of layer* Density.
∴ 28.26225 = 1*1.5* Height of layer* 150
∴ Material Height of layer = $\frac{28.26225}{1*1.5*150}$ m
∴ = $\frac{28.26225}{1*1.5*150*0.0254}$ inch
∴Material Height of layer = 4.945276 inch

Moving masses per meter of run :

Chain and flight mass per meter of run i.e. Rolling mass per meter of run =M_{cf}
∴ M_{cf} = Flight mass + Chain Mass
∴ M_{cf} = 24.28594 + 60
∴ M_{cf} = 84.28594 Kg/m
Mass of bagasse per meter =M_{mu} = 28.26225 Kg/m.

Conveying Resistance Factors:

Conveying Resistance Factors for rolling mass ,f_1
Friction coefficient steel pin on steel roller ,μ = 0.4
∴ $f_1 = 0.4*\frac{28}{75}$
= 0.1493 (for rolling mass)
Bagasse sliding / dragging factor , f_2 =0.35 to 0.45
Applicable to vertical load , f_2 = 0.45
Bagasse Horizontal pressure factor , f_3 = 0.0055
(For resistance = f_3*(Material Height in inch)^2

Upper run resistance per meter :

Chain and Flight rolling i.e. Rolling Resistance =
1* M_{cf} * f_1
= 1* 84.28594 *0.1493 =12.64289 Kgf/m
Bagasse sliding /Dragging on Bottom casing =
1 * M_{mu} * f_2
=1 * 28.26225 * 0.45 = 12.71801 Kgf/m
Bagasse Rubbing on sides = 1 * f_3 * (Material Height in inch)^2 =1 * 0.0055 * (4.945276)^2 = 0.134507 Kgf/m
∴ Total upper resistance = Chain and Flight rolling i.e. Rolling Resistance + Bagasse sliding /Dragging on Bottom casing + Bagasse Rubbing on sides
=12.64289 +12.71801 +0.134507 =25.49541
Upper run resistance = (Conveyor length * Chain and Flight rolling i.e. Rolling Resistance) - (Conveyor Height * Chain and flight mass per meter of run i.e. Rolling mass per meter of run ,M_{cf})
= (43.4*12.64289)–(19.5 *84.28594) = - 1094.87 Kgf
Lower run resistance = (Conveyor length * Chain and Flight rolling i.e. Rolling Resistance) +(Conveyor length * Bagasse sliding /Dragging on Bottom casing) +(Conveyor length * Bagasse Rubbing on sides) +[Conveyor height *(Chain and flight mass per meter of run i.e. Rolling mass per meter of Run ,M_{cf} + Mass of bagasse per meter ,M_{mu})]
∴ Lower run resistance = 3301.19 Kgf
Total resistance ,R = Upper run resistance + Lower run resistance+[(Upper run resistance +Lower run resistance)* 15%]
= 2537.264 Kgf

Now,Power required at sprocket shaft = Total resistance ,R * $\frac{\text{Chain and flight travel speed}}{102}$

= 9.951148 KW
Since, Here,Drive efficiency =90 % i.e 0.9
∴ Power required at Motor shaft = Power required at sprocket shaft / Drive efficiency = 11.05683 KW
Since, Here, we are selected ,
Safety factor = 1.6
∴ Motor required in H.P.= (Power required at Motor shaft * Safety factor) / 0.75
=23.58787 H.P.
So ,we are using 25 H.P. motor.
Now , we will calculate different iterations by changing slat angle .The calculations of these iterations are shown below in the table. First we will go on increasing the slat angle by 1^0.

Sr. No.	<ABC i.e. θ1	<BAC i.e. θ2	Height of slat AB	AC	BC	Water fill area A1	Top Area A2	Total Area A=A1+A2
1	90	59	0.29	0.563	0.482631	0.069982	0.030506	0.100488
2	91	58	0.29	0.562911	0.477498	0.069226	0.030496	0.099723
3	92	57	0.29	0.562652	0.472219	0.068429	0.030468	0.098898
4	93	56	0.29	0.562221	0.466796	0.067592	0.030422	0.098013
5	94	55	0.29	0.561618	0.46123	0.066714	0.030357	0.097071
6	95	54	0.29	0.560845	0.455525	0.065798	0.030273	0.096071
7	96	53	0.29	0.5599	0.44968	0.064845	0.030171	0.095016
8	97	52	0.29	0.558785	0.443699	0.063855	0.030051	0.093906
9	98	51	0.29	0.5575	0.437582	0.06283	0.029913	0.092742
10	99	50	0.29	0.556045	0.431332	0.06177	0.029757	0.091527
11	100	49	0.29	0.55442	0.42495	0.060679	0.029583	0.090262
12	101	48	0.29	0.552626	0.418439	0.059556	0.029392	0.088948
13	102	47	0.29	0.550664	0.411801	0.058403	0.029184	0.087587
14	103	46	0.29	0.548535	0.405037	0.057221	0.028959	0.08618
15	104	45	0.29	0.546238	0.398149	0.056013	0.028717	0.084729
16	105	44	0.29	0.543774	0.391141	0.054779	0.028458	0.083237

17	106	43	0.29	0.541145	0.384013	0.05352	0.028184	0.081704
18	107	42	0.29	0.538352	0.376768	0.05224	0.027893	0.080133
19	108	41	0.29	0.535394	0.369408	0.050938	0.027588	0.078525
20	109	40	0.29	0.532273	0.361936	0.049616	0.027267	0.076883
21	110	39	0.29	0.528989	0.354353	0.048277	0.026932	0.075209
22	111	38	0.29	0.525545	0.346663	0.046922	0.026582	0.073504
23	112	37	0.29	0.52194	0.338867	0.045552	0.026219	0.071771
24	113	36	0.29	0.518177	0.330967	0.04417	0.025842	0.070011
25	114	35	0.29	0.514255	0.322967	0.042776	0.025452	0.068228
26	115	34	0.29	0.510177	0.314868	0.041372	0.02505	0.066422
27	116	33	0.29	0.505943	0.306674	0.039961	0.024636	0.064597
28	117	32	0.29	0.501555	0.298386	0.038544	0.024211	0.062755
29	118	31	0.29	0.497015	0.290007	0.037123	0.023774	0.060897
30	119	30	0.29	0.492323	0.281539	0.035698	0.023328	0.059026
31	120	29	0.29	0.487481	0.272986	0.034273	0.022871	0.057144

Table 1: Cross-sectional area calculation by change slat angle

After this, we will take iterations by decreasing the slat angle by 1^0.

Sr. No.	<ABC i.e. θ1	<BAC i.e. θ2	Height of slat AB	AC	BC	Water fill area A1	Top Area A2	Total Area A=A1+A2
1	90	59	0.29	0.563	0.482631	0.069982	0.030506	0.100488
2	89	60	0.29	0.562916	0.487618	0.070694	0.030497	0.101191
3	88	61	0.29	0.562661	0.492456	0.071363	0.030469	0.101833
4	87	62	0.29	0.562235	0.497144	0.071988	0.030423	0.102411
5	86	63	0.29	0.561637	0.50168	0.072568	0.030359	0.102926
6	85	64	0.29	0.560869	0.506063	0.073101	0.030276	0.103377
7	84	65	0.29	0.559929	0.510293	0.073589	0.030174	0.103763
8	83	66	0.29	0.558819	0.514367	0.074029	0.030055	0.104084
9	82	67	0.29	0.557538	0.518284	0.074422	0.029917	0.104339
10	81	68	0.29	0.556087	0.522043	0.074767	0.029762	0.104528
11	80	69	0.29	0.554468	0.525643	0.075063	0.029588	0.104652
12	**79**	**70**	**0.29**	**0.552679**	**0.529083**	**0.075311**	**0.029398**	**0.104708**
13	78	71	0.29	0.550721	0.532362	0.075509	0.02919	0.104699
14	77	72	0.29	0.548596	0.535478	0.075658	0.028965	0.104623
15	76	73	0.29	0.546304	0.538432	0.075757	0.028724	0.104481
16	75	74	0.29	0.543845	0.541221	0.075807	0.028466	0.104273
17	74	75	0.29	0.541221	0.543845	0.075807	0.028192	0.103999
18	73	76	0.29	0.538432	0.546304	0.075757	0.027902	0.103659
19	72	77	0.29	0.535478	0.548596	0.075658	0.027596	0.103254
20	71	78	0.29	0.532362	0.550721	0.075509	0.027276	0.102785
21	70	79	0.29	0.529083	0.552679	0.075311	0.026941	0.102252

22	69	80	0.29	0.525643	0.554468	0.075063	0.026592	0.101655
23	68	81	0.29	0.522043	0.556087	0.074767	0.026229	0.100996
24	67	82	0.29	0.518284	0.557538	0.074422	0.025853	0.100275
25	66	83	0.29	0.514367	0.558819	0.074029	0.025463	0.099493
26	65	84	0.29	0.510293	0.559929	0.073589	0.025062	0.09865
27	64	85	0.29	0.506063	0.560869	0.073101	0.024648	0.097749
28	63	86	0.29	0.50168	0.561637	0.072568	0.024223	0.09679
29	62	87	0.29	0.497144	0.562235	0.071988	0.023787	0.095775
30	61	88	0.29	0.492456	0.562661	0.071363	0.02334	0.094703
31	60	89	0.29	0.487618	0.562916	0.070694	0.022884	0.093578
32	59	90	0.29	0.482631	0.563	0.069982	0.022418	0.0924
33	58	91	0.29	0.477498	0.562911	0.069226	0.021944	0.09117
34	57	92	0.29	0.472219	0.562652	0.068429	0.021461	0.089891
35	56	93	0.29	0.466796	0.562221	0.067592	0.020971	0.088563
36	55	94	0.29	0.46123	0.561618	0.066714	0.020474	0.087188
37	54	95	0.29	0.455525	0.560845	0.065798	0.019971	0.085769
38	53	96	0.29	0.44968	0.5599	0.064845	0.019462	0.084306
39	52	97	0.29	0.443699	0.558785	0.063855	0.018947	0.082802
40	51	98	0.29	0.437582	0.5575	0.06283	0.018428	0.081258
41	50	99	0.29	0.431332	0.556045	0.06177	0.017906	0.079676

Table 2: Cross-sectional area calculation by change slat angle

In above both the cases ,the maximum cross sectional area of bagasse will got at 79^0 slat angle. So for further iterations we will fix the slat angle at 79^0 . The power calculation results are shown in following table.

Sr. No	Height of slat (m)	Spacing between slat and trough (m)	Total height of slat (m)	Width of slat (m)	Thickness of slat (m)	Angle of slat	Cross sectional Area of bagasse filled between two slats (m2)	Slat material density (Kg/m3)	Slat Mass per meter (Kg)	Chain Mass for two Strands per meter (Kg)
1	0.275	0.015	0.29	1.5	0.006	90	0.100488	7850	24.2859 4	60
2	0.275	0.015	0.29	1.5	0.006	89	0.101191	7850	24.2859 4	60
3	0.275	0.015	0.29	1.5	0.006	88	0.101833	7850	24.2859 4	60
4	0.275	0.015	0.29	1.5	0.006	87	0.102411	7850	24.2859 4	60
5	0.275	0.015	0.29	1.5	0.006	86	0.102926	7850	24.2859 4	60
6	0.275	0.015	0.29	1.5	0.006	85	0.103377	7850	24.2859 4	60
7	0.275	0.015	0.29	1.5	0.006	84	0.103763	7850	24.2859 4	60
8	0.275	0.015	0.29	1.5	0.006	83	0.104084	7850	24.2859 4	60
9	0.275	0.015	0.29	1.5	0.006	82	0.104339	7850	24.2859 4	60

10	0.275	0.015	0.29	1.5	0.006	81	0.104528	7850	24.28594	60
11	0.275	0.015	0.29	1.5	0.006	80	0.104652	7850	24.28594	60
12	**0.275**	**0.015**	0.29	**1.5**	**0.006**	**79**	**0.104708**	7850	24.28594	60

Table 3: Power calculations by changing angle

Chain and slat mass per meter of run M*cf*	Mass of bagasse per slat	Mass of bagasse per meter M*mu*	Material height in upper run (inch)	Rolling resistance i.e chain & flight rolling/ mtr R1	Bagasse sliding /dragging Resistance on bottom R2	Bagasse rubbing on sides R3	R1+R2+R3	Upper run resistance (Kgf)
84.28594	22.6098	28.26225	4.945276	12.64289	12.71801	0.134507	25.49541	-1094.87
84.28594	22.76798	28.45997	4.979872	12.64289	12.80699	0.136395	25.58627	-1094.87
84.28594	22.91243	28.64053	5.011467	12.64289	12.88824	0.138131	25.66926	-1094.87
84.28594	23.04248	28.80309	5.039911	12.64289	12.96139	0.139704	25.74399	-1094.87
84.28594	23.15835	28.94794	5.065256	12.64289	13.02657	0.141112	25.81057	-1094.87
84.28594	23.25983	29.07478	5.087451	12.64289	13.08365	0.142352	25.86889	-1094.87
84.28594	23.34668	29.18334	5.106447	12.64289	13.1325	0.143417	25.91881	-1094.87
84.28594	23.4189	29.27363	5.122244	12.64289	13.17313	0.144306	25.96033	-1094.87
84.28594	23.47628	29.34534	5.134793	12.64289	13.2054	0.145014	25.99331	-1094.87
84.28594	23.5188	29.3985	5.144094	12.64289	13.22933	0.145539	26.01776	-1094.87
84.28594	23.5467	29.43338	5.150197	12.64289	13.24502	0.145885	26.03379	-1094.87
84.28594	**23.5593**	**29.44913**	**5.152953**	**12.64289**	**13.25211**	**0.146041**	**26.04104**	**-1094.87**

Table 4: Power calculations by changing angle

Lower run resistance (Kgf)	Total resistance (Kgf) R	Power required at sprocket shaft (KW)	Drive efficiency	Power required at motor shaft (KW)	H.P.of motor (H.P.)
3301.19	2537.264	9.951148	0.9	11.05683	23.58787
3308.989	2546.232	9.986323	0.9	11.09591	23.67125
3316.112	2554.423	10.01845	0.9	11.13161	23.7474
3322.525	2561.798	10.04737	0.9	11.16375	23.81596
3328.24	2568.37	10.07315	0.9	11.19239	23.87705
3333.244	2574.125	10.09572	0.9	11.21747	23.93056
3337.527	2579.051	10.11504	0.9	11.23893	23.97635
3341.09	2583.148	10.13111	0.9	11.25678	24.01443
3343.92	2586.402	10.14387	0.9	11.27097	24.04469
3346.017	2588.814	10.15333	0.9	11.28148	24.06711
3347.393	2590.397	10.15954	0.9	11.28837	24.08183
3348.015	**2591.112**	**10.16234**	**0.9**	**11.29149**	**24.08847**

Table 5: Power calculations by changing angle

From the above table, it is seen that the optimum result will get at 79^0 slat angle using 25 H.P.Motor.

4. Iterations for Various Heights of Slat

Now we will gone on increasing the slat height by 2 mm for each iterations . Here, Since we are taking ,height of slat on trial and error basic as 283mm i.e.0.283 m and their spacing between slat and trough is 15 mm i.e.0.015 m. So total height of slat becomes 298 mm.

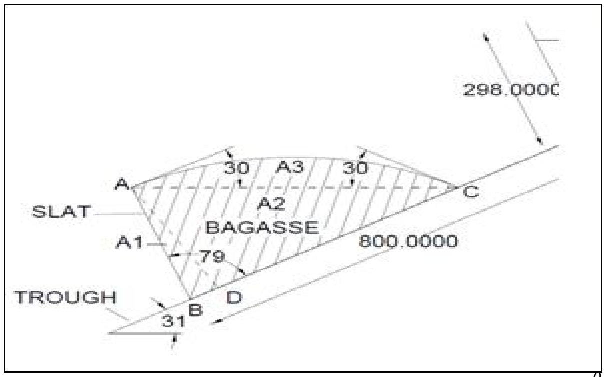


Figure 3.4: Cross-sectional of bagasse at slat angle 79^{0}

Sr. No.	θ1 B	θ2 C	Slat Height	Spacing between slat & Trough	Total Height of slat l(AB)	l(AC) b	l(BC) c	Water fill area A1	Top Area A2	Total Area A=A1+A2
1	79	70	0.275	0.015	0.29	0.552679	0.529083	0.075311	0.029398	0.104708
2	79	70	0.277	0.015	0.292	0.55649	0.532732	0.076353	0.029805	0.106158
3	79	70	0.279	0.015	0.294	0.560302	0.536381	0.077403	0.030214	0.107617
4	79	70	0.281	0.015	0.296	0.564113	0.54003	0.078459	0.030627	0.109086
5	**79**	**70**	**0.283**	**0.015**	**0.298**	**0.567925**	**0.543678**	**0.079523**	**0.031042**	**0.110565**
6	79	70	0.285	0.015	0.3	0.571737	0.547327	0.080594	0.03146	0.112054
7	79	70	0.287	0.015	0.302	0.575548	0.550976	0.081672	0.031881	0.113553
8	79	70	0.289	0.015	0.304	0.57936	0.554625	0.082758	0.032305	0.115062
9	79	70	0.291	0.015	0.306	0.583171	0.558274	0.08385	0.032731	0.116581
10	79	70	0.293	0.015	0.308	0.586983	0.561923	0.08495	0.03316	0.11811
11	79	70	0.295	0.015	0.31	0.590794	0.565572	0.086057	0.033593	0.119649
12	79	70	0.297	0.015	0.312	0.594606	0.56922	0.087171	0.034027	0.121198
13	79	70	0.299	0.015	0.314	0.598418	0.572869	0.088292	0.034465	0.122757
14	79	70	0.301	0.015	0.316	0.602229	0.576518	0.08942	0.034905	0.124325
15	79	70	0.303	0.015	0.318	0.606041	0.580167	0.090555	0.035349	0.125904
16	79	70	0.305	0.015	0.32	0.609852	0.583816	0.091698	0.035795	0.127493
17	79	70	0.307	0.015	0.322	0.613664	0.587465	0.092848	0.036244	0.129091
18	79	70	0.309	0.015	0.324	0.617476	0.591114	0.094005	0.036695	0.1307
19	79	70	0.311	0.015	0.326	0.621287	0.594762	0.095169	0.03715	0.132319
20	79	70	0.313	0.015	0.328	0.625099	0.598411	0.09634	0.037607	0.133947
21	79	70	0.315	0.015	0.33	0.62891	0.60206	0.097519	0.038067	0.135586
22	79	70	0.317	0.015	0.332	0.632722	0.605709	0.098704	0.03853	0.137234
23	79	70	0.319	0.015	0.334	0.636533	0.609358	0.099897	0.038995	0.138893
24	79	70	0.321	0.015	0.336	0.640345	0.613007	0.101097	0.039464	0.140561
25	79	70	0.323	0.015	0.338	0.644157	0.616655	0.102304	0.039935	0.142239
26	79	70	0.325	0.015	0.34	0.647968	0.620304	0.103519	0.040409	0.143927

27	79	70	0.327	0.015	0.342	0.65178	0.623953	0.10474	0.040886	0.145626
28	79	70	0.329	0.015	0.344	0.655591	0.627602	0.105969	0.041365	0.147334
29	79	70	0.331	0.015	0.346	0.659403	0.631251	0.107204	0.041848	0.149052
30	79	70	0.333	0.015	0.348	0.663214	0.6349	0.108447	0.042333	0.15078
31	79	70	0.335	0.015	0.35	0.667026	0.638549	0.109697	0.042821	0.152518
32	79	70	0.337	0.015	0.352	0.670838	0.642197	0.110955	0.043312	0.154266

Table 6: Cross –Sectional area calculations by changing height of slat

The power calculations of above each configuration are shown in following table

Sr. No	Height of slat (m)	Spacing between slat and trough (m)	Total height of slat (m)	Thickness of slat (m)	Width of slat (m)	Angle of slat	Cross sectional Area of Bagass filled between two slats (m2)	Slat material density (Kg/m3)	Slat Mass per meter (Kg)
1	0.275	0.015	0.29	0.006	1.5	79	0.104708	7850	24.28594
2	0.277	0.015	0.292	0.006	1.5	79	0.106158	7850	24.46256
3	0.279	0.015	0.294	0.006	1.5	79	0.107617	7850	24.63919
4	0.281	0.015	0.296	0.006	1.5	79	0.109086	7850	24.81581
5	**0.283**	**0.015**	**0.298**	**0.006**	**1.5**	**79**	**0.110565**	**7850**	**24.99244**
6	0.285	0.015	0.3	0.006	1.5	79	0.112054	7850	25.16906
7	0.287	0.015	0.302	0.006	1.5	79	0.113553	7850	25.34569
8	0.289	0.015	0.304	0.006	1.5	79	0.115062	7850	25.52231
9	0.291	0.015	0.306	0.006	1.5	79	0.116581	7850	25.69894
10	0.293	0.015	0.308	0.006	1.5	79	0.11811	7850	25.87556
11	0.295	0.015	0.31	0.006	1.5	79	0.119649	7850	26.05219
12	0.297	0.015	0.312	0.006	1.5	79	0.121198	7850	26.22881
13	0.299	0.015	0.314	0.006	1.5	79	0.122757	7850	26.40544
14	0.301	0.015	0.316	0.006	1.5	79	0.124325	7850	26.58206
15	0.303	0.015	0.318	0.006	1.5	79	0.125904	7850	26.75869
16	0.305	0.015	0.32	0.006	1.5	79	0.127493	7850	26.93531
17	0.307	0.015	0.322	0.006	1.5	79	0.129091	7850	27.11194
18	0.309	0.015	0.324	0.006	1.5	79	0.1307	7850	27.28856
19	0.311	0.015	0.326	0.006	1.5	79	0.132319	7850	27.46519
20	0.313	0.015	0.328	0.006	1.5	79	0.133947	7850	27.64181
21	0.315	0.015	0.33	0.006	1.5	79	0.135586	7850	27.81844
22	0.317	0.015	0.332	0.006	1.5	79	0.137234	7850	27.99506
23	0.319	0.015	0.334	0.006	1.5	79	0.138893	7850	28.17169
24	0.321	0.015	0.336	0.006	1.5	79	0.140561	7850	28.34831
25	0.323	0.015	0.338	0.006	1.5	79	0.142239	7850	28.52494
26	0.325	0.015	0.34	0.006	1.5	79	0.143927	7850	28.70156
27	0.327	0.015	0.342	0.006	1.5	79	0.145626	7850	28.87819
28	0.329	0.015	0.344	0.006	1.5	79	0.147334	7850	29.05481
29	0.331	0.015	0.346	0.006	1.5	79	0.149052	7850	29.23144

30	0.333	0.015	0.348	0.006	1.5	79	0.15078	7850	29.40806
31	0.335	0.015	0.35	0.006	1.5	79	0.152518	7850	29.58469
32	0.337	0.015	0.352	0.006	1.5	79	0.154266	7850	29.76131

Table 7: Power calculations by changing height of slat

Chain Mass for two Strands per meter (Kg)	**Chain and slat mass per meter of run M*cf***	**Mass of bagasse per slat**	**Mass of bagasse per meter M*mu***	**Material height in upper run (inch)**	**Rolling resistance i.e chain & flight rolling/ mtr R1**	**Bagasse sliding /dragging Resistance on bottom R2**	**Bagasse rubbing on sides R3**	**R1+R2+R3**
60	84.28594	23.5593	29.44913	5.152953	12.64289	13.25211	0.146041	26.04104
60	84.46256	23.88555	29.85694	5.224311	12.66938	13.43562	0.150114	26.25512
60	84.63919	24.21383	30.26728	5.296112	12.69588	13.62028	0.154268	26.47042
60	84.81581	24.54435	30.68044	5.368406	12.72237	13.8062	0.158509	26.68708
60	**84.99244**	**24.87713**	**31.09641**	**5.441191**	**12.74887**	**13.99338**	**0.162836**	**26.90508**
60	85.16906	25.21215	31.51519	5.514469	12.77536	14.18183	0.167251	27.12445
60	85.34569	25.54943	31.93678	5.588238	12.80185	14.37155	0.171756	27.34516
60	85.52231	25.88895	32.36119	5.6625	12.82835	14.56253	0.176351	27.56723
60	85.69894	26.23073	32.78841	5.737254	12.85484	14.75478	0.181038	27.79066
60	85.87556	26.57475	33.21844	5.8125	12.88133	14.9483	0.185818	28.01545
60	86.05219	26.92103	33.65128	5.888238	12.90783	15.14308	0.190692	28.2416
60	86.22881	27.26955	34.08694	5.964469	12.93432	15.33912	0.195662	28.46911
60	86.40544	27.62033	34.52541	6.041191	12.96082	15.53643	0.200728	28.69798
60	86.58206	27.97313	34.96641	6.118356	12.98731	15.73488	0.205889	28.92808
60	86.75869	28.3284	35.4105	6.196063	13.0138	15.93473	0.211152	29.15968
60	86.93531	28.68593	35.85741	6.274262	13.0403	16.13583	0.216515	29.39264
60	87.11194	29.04548	36.30684	6.352904	13.06679	16.33808	0.221977	29.62685
60	87.28856	29.4075	36.75938	6.432087	13.09328	16.54172	0.227545	29.86255
60	87.46519	29.77178	37.21472	6.511762	13.11978	16.74662	0.233217	30.09962
60	87.64181	30.13808	37.67259	6.59188	13.14627	16.95267	0.238991	30.33793
60	87.81844	30.50685	38.13356	6.672539	13.17277	17.1601	0.244875	30.57774
60	87.99506	30.87765	38.59706	6.753642	13.19926	17.36868	0.250864	30.8188
60	88.17169	31.25093	39.06366	6.835285	13.22575	17.57865	0.256966	31.06136
60	88.34831	31.62623	39.53278	6.917372	13.25225	17.78975	0.263175	31.30517
60	88.52494	32.00378	40.00472	6.999951	13.27874	18.00212	0.269496	31.55036
60	88.70156	32.38358	40.47947	7.083022	13.30523	18.21576	0.275931	31.79693
60	88.87819	32.76585	40.95731	7.166634	13.33173	18.43079	0.282484	32.045
60	89.05481	33.15015	41.43769	7.250689	13.35822	18.64696	0.289149	32.29433
60	89.23144	33.5367	41.92088	7.335236	13.38472	18.86439	0.295931	32.54504
60	89.40806	33.9255	42.40688	7.420276	13.41121	19.08309	0.302833	32.79714
60	89.58469	34.31655	42.89569	7.505807	13.4377	19.30306	0.309854	33.05062
60	89.76131	34.70985	43.38731	7.591831	13.4642	19.52429	0.316997	33.30548

Table 8: Power calculations by changing height of slat

Upper run resistance (Kgf)	Lower run resistance (Kgf)	Total resistance (Kgf) R	Power required at sprocket shaft (KW)	Drive efficiency	Power required at motor shaft (KW)	H.P.of motor (H.P.)
-1094.87	3348.015	2591.112	10.16234	0.9	11.29149	24.08847
-1097.17	3368.702	2612.264	10.2453	0.9	11.38367	24.28511
-1099.46	3389.493	2633.534	10.32872	0.9	11.47636	24.48285
-1101.76	3410.396	2654.934	10.41265	0.9	11.56961	24.68181
-1104.05	**3431.413**	**2676.466**	**10.4971**	**0.9**	**11.66344**	**24.88197**
-1106.35	3452.544	2698.127	10.58206	0.9	11.75784	25.08335
-1108.64	3473.788	2719.92	10.66753	0.9	11.85281	25.28595
-1110.93	3495.146	2741.843	10.75351	0.9	11.94834	25.48976
-1113.23	3516.618	2763.897	10.84	0.9	12.04445	25.69478
-1115.52	3538.204	2786.082	10.92701	0.9	12.14113	25.90103
-1117.82	3559.903	2808.398	11.01454	0.9	12.23837	26.10849
-1120.11	3581.716	2830.845	11.10257	0.9	12.33619	26.31717
-1122.41	3603.644	2853.423	11.19112	0.9	12.43458	26.52707
-1124.7	3625.674	2876.119	11.28014	0.9	12.53349	26.73806
-1127	3647.829	2898.959	11.36972	0.9	12.63302	26.9504
-1129.29	3670.099	2921.93	11.45981	0.9	12.73312	27.16395
-1131.58	3692.471	2945.02	11.55037	0.9	12.83374	27.37861
-1133.88	3714.969	2968.255	11.64149	0.9	12.93499	27.59461
-1136.17	3737.582	2991.62	11.73313	0.9	13.03682	27.81183
-1138.47	3760.297	3015.104	11.82524	0.9	13.13916	28.03015
-1140.76	3783.138	3038.733	11.91791	0.9	13.24212	28.24982
-1143.06	3806.082	3062.481	12.01105	0.9	13.34561	28.47059
-1145.35	3829.152	3086.373	12.10475	0.9	13.44973	28.6927
-1147.64	3852.326	3110.383	12.19892	0.9	13.55436	28.91592
-1149.94	3875.614	3134.526	12.29361	0.9	13.65957	29.14037
-1152.23	3899.017	3158.801	12.38882	0.9	13.76535	29.36604
-1154.53	3922.545	3183.22	12.48459	0.9	13.87177	29.59306
-1156.82	3946.178	3207.759	12.58083	0.9	13.9787	29.82118
-1159.12	3969.925	3232.43	12.67759	0.9	14.08621	30.05054
-1161.41	3993.787	3257.233	12.77487	0.9	14.1943	30.28112
-1163.71	4017.764	3282.168	12.87266	0.9	14.30296	30.51293
-1166	4041.856	3307.235	12.97098	0.9	14.4122	30.74597

Table 9: Power calculations by changing height of slat

From the above table, it is seen that the optimum result will get at 79 ^{0} slat angle and 283 mm slat height using 25 H.P.Motor.

5. Results

The traditional slat conveyor can carry maximum 22.6098 Kg /m^3 bagasse per slatby using 25 H.P.motor.. By using the our optimum configuration ,the slat conveyor can carry maximum 24.87713 Kg /m^3 bagasse per slat for the same motor. That means mass each slat can carry 2.26733 Kg /m^3 extra bagasse per slat. It ultimately impacts on the capacity of the slat conveyor system. In other words the optimum configuration of slat conveyor will increase the performance by 10.028 %.

6. Conclusion

We wish to state that , by using our optimum configuration ,we can increase the capacity of the slat conveyor for the same motor. In our opinion the above method of conveying and storing the bagasse is by no means the ideal one ; the storage shed and the slat conveyor used overseas is considered far superior. Belt conveyors and slat conveyors as used in some mills appear to be an effortless means of conveying bagasse but there are limitations to these as regards a satisfactory method of feeding to the individual fire openings; also their limit of elevation appears to be between 30^0 and 35^0 .These limitations can, no doubt, be quite easily overcome.

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