AUGER BASED SEWAGE WASTE AND DRAINAGE SCAVENGING SYSTEM

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Abstract - *Considering the importance of regular maintenance of underground sewer line and open sewer network for flawless transportation of public waste and rain water management. Due to large amount of waste flow and other solid waste sewer lines get choked and problems like sewer overflow and water ponding on roads arises. This project has done to provide an economical and innovative solution for scavenging of solid and semisolid waste from sewer line pipes through manhole to avoid the choking of pipeline. In current situation generally the waste scavenging is done manually which expose the worker with direct contact of hazardous gases (for example- methane, carbon mono oxide, Hydrogen sulphide etc.) trapped beneath the layer of semisolid silt. Despite law and Supreme Court order (manual scavenging is banned since 1993) practice is being continuously done; risking the workers life and so multiple deaths has been spotted in various cities of India. Tojhis prect also provides a cheap and handy solution for direct exposure.*

Key Words: **Auger, sewer pipe, solid modelling**

1. INTRODUCTION

Sewage usually comprises urea, silt, faeces, fats, carbs, grease, proteins and mainly of domestic waste. Dissolved inorganic matter is also found in sewage including nitrogen species dissolved salts and phosphorous species mainly from agricultural areas. The sewage maintenance is vey important as sewage directly affects the people and oxygen level both. The sewage in India is passed through pipes that are placed underground. Now when the sewage passes through these pipes in underground drainage system, it gets collected at someplace like bends in pipes and due to elevation difference. The main cause of sewer line blockage is poor maintenance of drainage system, accumulation of silt at comers of the pipes. Some of the reasons comprises the dumping of non-degradable wastes in the sewer channel like cloth, solid wastes including plastics, paper and food and garden wastes

The city of Lucknow, capital of Uttar Pradesh, also faces such problems and is considered to have a sewer line length of 2300 km across the city. Jal Nigam is the department which deals with the sewer issues and is having a dream of building an Independent Sewage Treatment Plants (STP) on the biggest drain of Lucknow i.e. Ghiyasudddin Haider (GH) canal, along with some of the following projects are in work in progress and will be inaugurated in coming years.

- 43/EE/JNNURM-/09-10 (LKO District-I
- 16/EE(P)/JNNURM-DR-03/09-10 (LKO District-III)
- UP Jal Nigam-11GM
- UP Jal Nigam-13GM
- UP Jal Nigam-22GM

The sewage in Lucknow is estimated to be 600 million litres daily (MLD), out of which 401 million is treated and remaining sewage is flowed into the Gomti river. The estimated growth in Lucknow is going to be around 1000 MLD in next 15 years and hence we have to prepare today for those issues.

According to the Supreme Court Decision in 2013, it is completely prohibited to use manual scavenging or manual labour for the cleansing of sewage in sewer lines through manholes.

So, what we propose here is an alternative to the manual scavenging traditional methods involving risking of humans lives during scavenging process. The sewer lines are filled with various disastrous gases involving methane which is trapped in the layers of silt and get released during the removal of waste sewage hence causing various hazardous effects. The silt itself causes a number of diseases which sometimes become the cause of deaths of the workers involved.

The actual design of the sewer pipe which comes into play is given below.

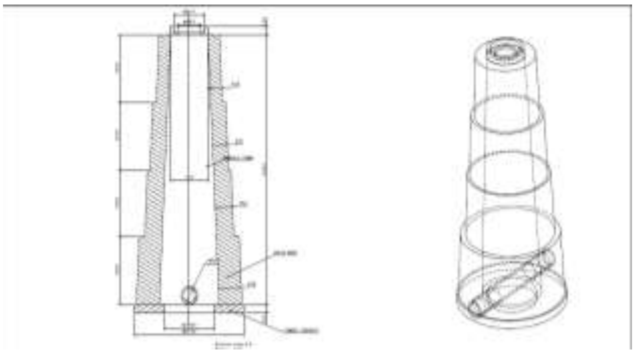

Fig.1.1 Sketch of sewer pipeline

2. SOLID MODELLING

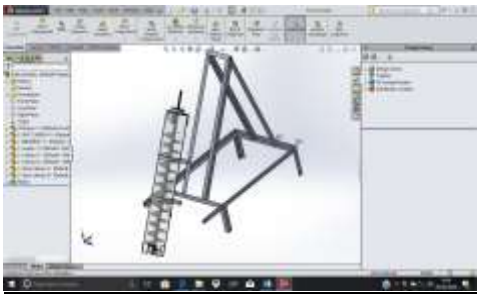

Fig 2.1 The complete solid modelling of the proposed model using the design software named SOLIDWORKS 2016.

3. FRAME

A design made in solidworks. The basic structure was made using 3-D sketch and further adding L cross section structural member

Fig. 3.1 Solid Model of Frame

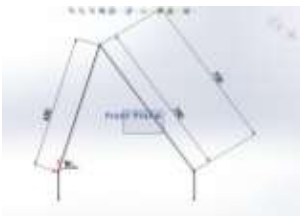

Fig. 3.2 Side View

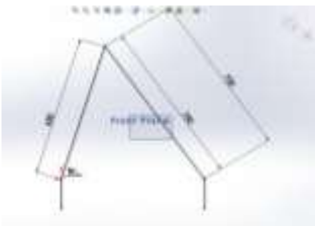

Fig. 3.3 Front View

3.1 PROPERTIES OF FRAME

Configuration: Default<As Machined>

Coordinate system: -- default --

Density = 7200.00 kilograms per cubic meter

Mass = 7.49 kilograms

Volume = 1040933.26 cubic millimetres

Surface area = 555385.87 square millimetres

Centre of mass: (millimetres)

X = -295.86

Y = 155.98

Z = 224.98

Principal axes of inertia and principal moments of inertia: (grams * square millimetres). Taken at the centre of mass.

Ix = (0.78, 0.62, -0.00) Px = 60311870.76

Iy = (-0.62, 0.78, -0.00) Py = 83973728.26

Iz = (0.00, 0.00, 1.00) Pz = 98226896.42

Moments of inertia: (grams * square millimetres)

Taken at the centre of mass and aligned with the output coordinate system.

Lxx = 69400617.00 Lxy = 11508749.21 Lxz = -1305.13

Lyx = 11508749.21 Lyy = 74884982.20 Lyz = -2036.03

Lzx = -1305.13 Lzy = -2036.03 Lzz = 98226896.24

Moments of inertia: (grams * square millimetres)

Taken at the output coordinate system.

(Ixx = 147416441.48 Ixy = -36529573.77

Ixz = -69290558.29)

(Iyx = -36529573.77 Iyy = 218693097.60

Iyz = 36527772.00)

(Izx = -69290558.29 Izy = 36527772.00

Izz = 214671507.30)

4. AUGER

Fig. 4.1 Solid Model of Auger

4.1 DIMENSIONAL PROPERTIES

Shaft Diameter = 18mm

Outer Diameter = 100 mm

Pitch = 50 mm

Revolution = 12

Start angle = 0^0 clockwise

4.2 MASS PROPERTIES OF AUGER

Configuration: Default

Coordinate system: -- default --

Density = 7200.00 kilograms per cubic metre

Mass = 1.30 kilograms

Volume = 180673.07 cubic millimetres

Surface area = 262315.31 square millimetres

Center of mass: (millimetres)

X = 0.02

Y = -369.39

Z = -0.03

Principal axes of inertia and principal moments of inertia: (grams * square millimetres)

Taken at the centre of mass.

Ix = (-0.00, 1.00, -0.00) Px = 558397.31)

Iy = (0.38, 0.00, 0.93) Py = 60018527.00)

Iz = (0.93, -0.00, -0.38)Pz = 60026042.76)

Moments of inertia: (grams * square millimetres)

Taken at the centre of mass and aligned with the output coordinate system.

Lxx = 60024972.13 Lxy = -11703.28

Lxz = 2648.02

Lyx = -11703.28 Lyy = 558639.71

Lyz = -119483.14

Lzx = 2648.02 Lzy = -119483.14

Lzz = 60019355.23

Moments of inertia: (grams * square millimetres)

Taken at the output coordinate system.

Ixx = 239990152.57 Ixy = -20026.92

Ixz = 2647.41

Iyx = -20026.92 Iyy = 558641.04

Iyz = -106439.84

Izx = 2647.41 Izy = -106439.84

Izz =239984535.11

5. CLAMP

Clamp is a mechanical device used to hold the PVC casing with the rack and pinion arrangement

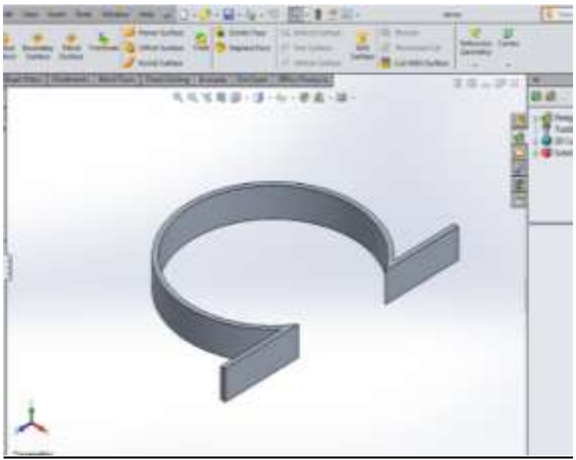

Fig. 5.1 Solid model

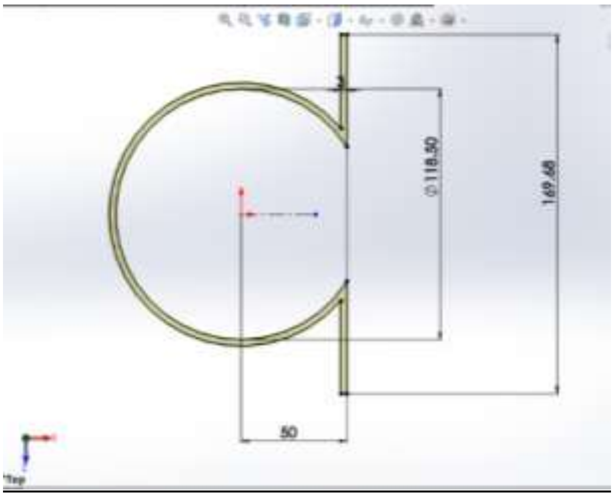

Fig. 5.2 Top View

6. PVC CASING

PVC casing is installed to hold the wastages pulling out off with the help of auger.

It has a diameter of 100 mm and 2.5 feet in length.

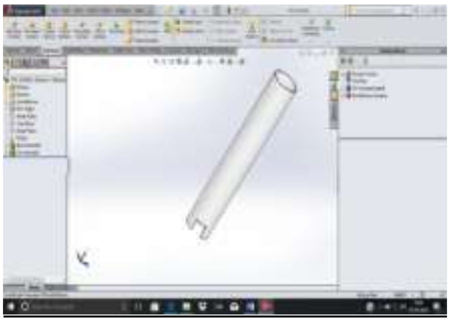

Fig. 6.1 Solid Model

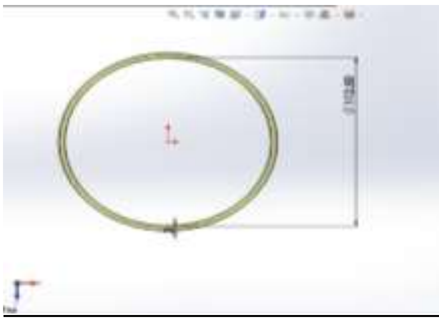

Fig. 6.2 Top View

7. Assembly of Auger and PVC Casing

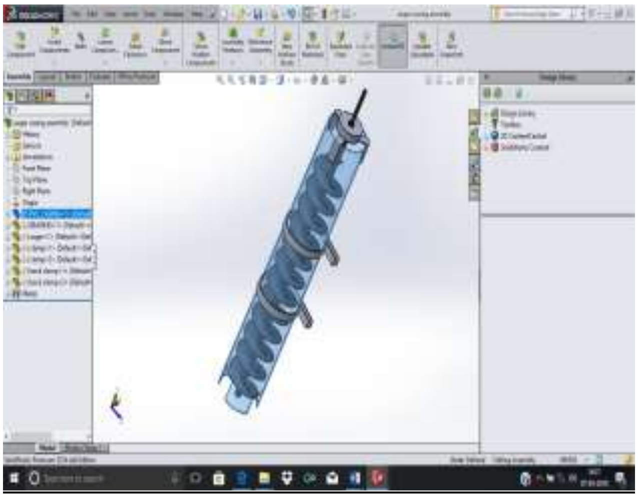

Fig 7.1 Assembly in Solidworks

8. COMPONENTS

8.1 FRAME

It is made up of iron L cross section structural bars. It is joined using the Electric Arc Welding Process. On the front portion, the Sliding Liner mechanism is welded on which the rack of the rack and pinion mechanism is mounted using fasteners.

Fig. 8.1 Frame

It's significance in our project is to hold the Auger and the Casing Assembly involving the motor to rotate the auger and also to make the movement in up and down directions. The inclined shape of the front of the frame helps in the ease of removal of waste.

8.2 Rack and Pinion Gear

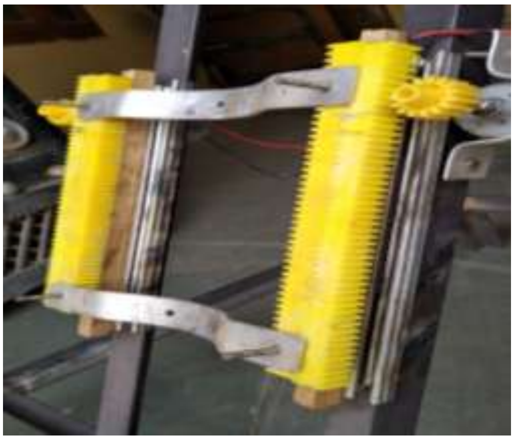

Fig. 8.2 Rack and Pinion Gear

The rack and the pinion gear assembly is used for the conversion of the rotary motion to the translatory motion. As per the requirement in this project the rack and pinion gear transform the rotations from the motor and makes the auger move linearly in the up and down directions.

8.3 Clamp

Fig. 8.3 Clamp

The clamp is used to hold the casing of the Auger with the use of nuts and bolts. It helps in fixing the casing on the Sliding Liner and the Rack and Pinion assembly.

8.4 PVC Casing

Fig. 8.4 PVC Casing

The PVC Casing is fixed on the Sliding Liner along with the Rack and Pinion assembly. This casing is present to cover the rotating Auger in order to permit the Auger to lift the waste material and hold it up to a particular height.

The PVC casing is also having a Rectangular Hole which acts as the Outlet for the waste material.

8.5 Auger

Fig. 7.5 Auger

The auger made by firstly cutting the sheet metal into circular parts. Each circular part is then allowed to get a shape of auger by cutting and bending it radially. A long shaft of length 2.5 feet and diameter of 18 mm is used as a rotating medium on which each plate is mounted.

The resultant assembly is then act as auger which helps to pull out the wastage materials.

8.6 MOTOR

Fig. 8.6 Motor

A helical gear DC motor used for rotational moment of auger inside the PVC pipe. It has the following specifications:

1. 50 RPM
2. Voltage = 12-30 V
3. Torque = 50 Kg Cm

Load Current = 700 mA

8.7 TRACTION MOTOR

Fig. 8.7 Traction motor

The traction motor used in rack and pinion arrangement with the following specifications-

- 60 rpm
- 12-33 Volt with gear box
- 125-gram weight
- No load current = 60 mA
- Load current = 300 mA

8.8 SWITCH BOX

Fig 8.8 Switch Box

The switch box is installed to operate the rack & pinion arrangement and the motor (to rotate the auger inside the PVC pipe).

9. Working model

Above pic shows the complete working model of the auger based scavenging system.

Purpose

The assembly of auger and PVC casing is installed to pull out the waste materials in upward direction. While doing so, the wastages may spread out in several directions. To overcome this problem, the PVC casing is mounted all around the auger to make the operation easy and efficient.

10. CALCULATIONS

10.1 Material flux calculation

Conveyor housing filled area,

$$S = \frac{\lambda.\pi}{4}(D_0^2 - D_i^2)$$

D_o= outer diameter of screw

D_i= Diameter of shaft

λ = fill coefficient

Travelling speed: $V = \frac{PN}{60}$

P= pitch

N= rpm of screw

Transported material flux (kg/hr)

Q = 3600.S.V.ρ.k

ρ= material density

K=conveyor housing inclination coefficient

$Q = 3600. \frac{\lambda.\pi}{4}(D_0^2 - D_i^2). \frac{PN}{60}.\rho.k$

$Q = 15\pi. (D_0^2 - D_i^2).\lambda.P.N.f.k$ kg/hr

10.2 Power Calculation

The total power to pull the silt material out will be sum of power required to move material horizontally (P_H) and power required to move unloaded screw (P_{UN}) and power required when screw is inclined (P_{IN})

$$P = P_H + P_{UN} + P_{IN}$$

P_H (KW) $= C_0. \frac{Q.g.L}{3600}$

where, L = flute length

g = acceleration due to gravity

C_0 = material resistance coefficient

Inclined: P_{IN} (KW) = $\frac{Q.g.H}{3600}$

, H = installation height

P_{UN} = gL is much less than the power required to move material.

$P_{UN} = \frac{1}{2}(I_{SCREW})(\frac{2\pi N}{60})^2(\frac{1}{3600})$

I_{SCREW} = MOI of screw

$I = 2.4 \times 10^8$ gm-mm^2

$I = 0.24$ kg-m^2

Torque (T) for driving motor = $\frac{60P}{2\pi N} = \frac{30P}{\pi N}$ KN-m

11. RESULT & DISCUSSION

Our system is low cost alternative solution of manual scavenging. It is simple in construction and by means of using just an auger, motor, frame, rack and pinion arrangement & bearing. It is light weight and easily portable. It can easily move and reach to all the places where bulky machines and trucks cannot. We can control the depth of working by the help of rack and pinion arrangement. It does not work only for specific kind of sewer but can be used in mostly all types of gutters and sewers. It helps the operator to work more easily and effectively by minimizing the risk of deaths of workers involved in scavenging. This literature review highlights the preceding advancements of the sewer waste scavenging system. This system mainly focuses on providing an alternative and more effective solution of manual scavenging by the help of specially designed auger. This system is completely based on Archimedes screw (which is one of the oldest machines for lifting water, for irrigation and drainage purposes). Uplifting of silt and waste water is controlled by the help of motor. Here, Power of Motor = 50 kg-cm, RPM=50, which gives 0.684 kg per hour.

APPENDIX 1

Type of load	λ
Heavy and abrasive	0.125
Heavy & a little abrasive	0.25
Light & a little abrasive	0.32
Light not abrasive	0.4

APPENDIX 2

Material	Speed(N)
Heavy	N=50 rpm
Light	N<150 rpm

APPENDIX 3

Conveyor housing inclination	K
0°	1
5°	0.5
10°	0.8
15°	0.7
20°	0.6

APPENDIX 4

Material	C_0
Granular	1.2
Soda, coal dust	1.6
Coal, rock salt	2.5
Dry clay, cement, sand	4

12. CONCLUSION

Our project fulfills our Initial Objective to provide a cheap and handy solution for the problems related to sewer lines choking. The project was tested with the Silt as in actual situations and we were rewarded with the satisfactory result while comparing with the present technology including Super Sucker Machines not only on the basis of performance, even on financial level as this is far cheaper as compared to those heavy machines. We hope this project will be the solution and will be replacing the process of Manual

Scavenging which is a curse to our society being the cause of the Racial Discrimination, Innumerous Diseases, Inevitable release of toxic gases and other social issues.

PROPOSED APPLICATION/SCOPE OF THE PROJECT

According to the data, in India, automated machines needed for the scavenging of drainage, are far more expensive. Hence, this system is a better alternative in the following ways-

- This system will be a good replacement of these expensive machines. It is very helpful and will become efficient and easy for the workers, involve in the present manual scavenging of drainage.
- A very cost-effective model for the country like India, where the manual scavenging is at risk along with the risk of life of workers.
- It will be geographically handy i.e. It can be adjusted and applied to any congested or narrow places. We can control depth as per the requirements and conditions.
- This is capable of moving in narrow streets as well as main roads where large super sucker machines can't reach.

13. NOMENCLATURE/UNITS

Ix Principal axis of inertia

Px Principal moment of inertia

X Coordinate in x-axis

Y Coordinate in y-axis

Z Coordinate in z-axis

PVC Polyvinyl Chlorde

rpm revolutions per minute

mA mili-ampere

Q material flux, (kg/hr)

g acceleration due to gravity, 9.8 m/s^2

13.1 SYMBOLS

λ fill coefficient (Appendix I)

ρ density

C_0 material resistance coefficient (Appendix 4)

K conveyor housing inclination coefficient (Appendix3)

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