Design and Fabrication of Pipe Crawling and Open Channel Drainage Cleaning Machine

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***Abstract* - In this open channel seepage(drainage) cleaning and pipe creeping(crawling) machine, a standout amongst the most essential necessities of repairing and keeping up of pipelines is the capacity to screen and assess the funnel's inside. The component utilizes three free elastic wheels which are circumferentially separated out 1200 separated symmetrically. The mechanical assembly utilizes a dynamic mode to adjust to an extensive variety of pipeline breadths from 200 to 250 mm. In any case, this reach can be effortlessly stretched out by expanding the length of the machine linkages. At long last, a model unit is constructed and tried in various circumstances.**

The target of this anticipates is to assemble an open channel seepage cleaning and pipe slithering machine that can be controlled by switches.
***Index Terms* – Internal pipe crawler, Open channel drainage.**

I. *INTRODUCTION*

Seepage(drainage) is the common or simulated expulsion of surface and sub-surface water from a zone. Numerous rural soils need seepage to enhance creation or to oversee water supplies.

1.1 HISTORY:

Figure.1.1 Remains of a drain at Lethal dating back to 2900BC

The old Indus frameworks of sewerage and seepage that were created and utilized as a part of urban communities all through the human progress were much more progressed than any found in contemporary urban refers to in the Center East and significantly more effective than those in a few ranges of advanced Pakistan and India today. All houses in the significant urban communities of Harappa and Mohenjo-Daro had access to water and seepage offices. Waste water was coordinated to secured channels, which coated the real roads.

1.2 DRAINAGE IN THE 19th CENTURY

This operation is constantly best performed in spring or summer, when the ground is dry. Primary channels should be made in all aspects of the field where a cross-cut or open channel was in the past needed; they should be cut four feet 1.2 m profound, upon a normal.

Figure 1.2 Tank Stream, a historical drain in the city of Sydney from the 1881 Household cyclopedia

1.3 21ST CENTURY ALTERNATIVES

Figure.1.3 21st Century Alternatives

Seattle's Open Utilities made an experimental run program called Road Edge Options (Ocean Boulevards) Venture. The venture concentrates on planning a framework "to give seepage that all the more nearly imitates the characteristic scene preceding improvement than customary funneled frameworks" The boulevards are portrayed by trench at the edge of the roadway, with plantings composed all through the region.

1.4 PIPE CRAWLER

Funnel(pipe) crawlers have built up a scope of fastened mediation crawler devices that are intended to get to pipeline frameworks at present thought to be unpiggable. Funnel crawlers are making the mediation crawler conveyance framework accessible to their customers, who are sans then to choose which innovation or complimentary mixes of advances they wish to have coordinated inside the particular device design for every particular application they have. If a customer has no specific inclination with respect to innovation supplier, Funnel crawlers will give a proposal. Mix of both set up and new pipeline assessment and intercession advancements into the scope of crawlers will be completed by Pipe crawlers in organization with the customer and innovation supplier. Amid operations Funnel crawlers will be in charge of insertion of the instrument into the pipeline and pilot the device to pre-decided journey goes or to particular areas. Information accumulation and examination will be the obligation of the investigation innovation supplier.

II. *METHODOLOGY*

2.1 PIPE CRAWLER

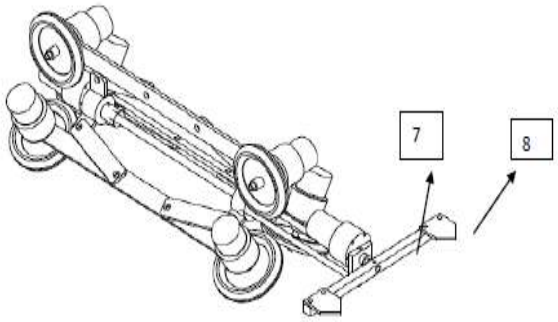


Figure 2.1 Pipe crawler

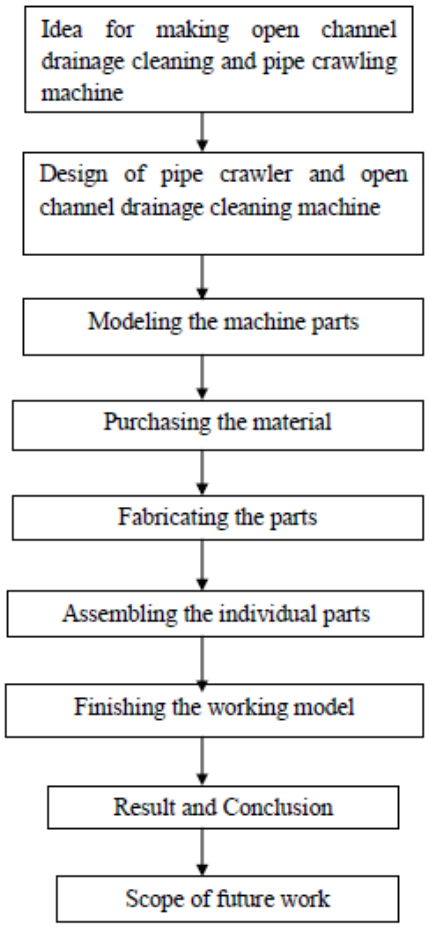


Figure 2.2 Block diagram of methodology

2.2 OPEN DRAINAGE CLEANING MACHINE

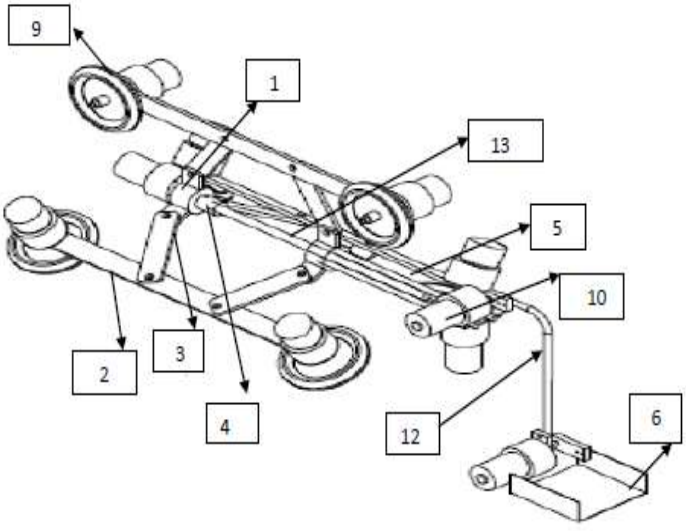


Figure.2.3 open channel drainage

2.3 DETAILS OF THE MATERIAL:

Table.2.1 Details of the material

Items no	Description	Material	No off
1	Spider nut	A36 steel	2
2	Link 1	A36 steel	3
3	Link 2	A36 steel	6
4	Bush	A36 steel	2
5	Rod	A36 steel	1
6	Bucket	A36 steel	1
7	Square rod	A36 steel	1
8	Blade	A36 steel	2
9	Wheels	RUBBER	6
10	Motors	_	11
11	Channel	A36 steel	1
12	Shaft	CARBON STEEL	2
13	Lead screw	CARBON STEEL	1

III. DESIGN CALCULATION

3.1 FOR CALCULATING TORQUE, POWER TO LIFT THE LOAD BY USING MOTOR:

Assumed weight=2.5kg, Arm length=167.6mm

1) Torque (T) =W×L

= 2.5×9.81×0.1676

= 4.1103 N-m

The torque is 4.1103 N-m hence choose arm motor having actual torque is 4.41 N-m

3.2 FOR CALCULATING TORQUE, POWER TO ROTATION OF THE CRAWLER BY USING MOTOR:

Assumed weight=0.75kg, Shaft length=18mm

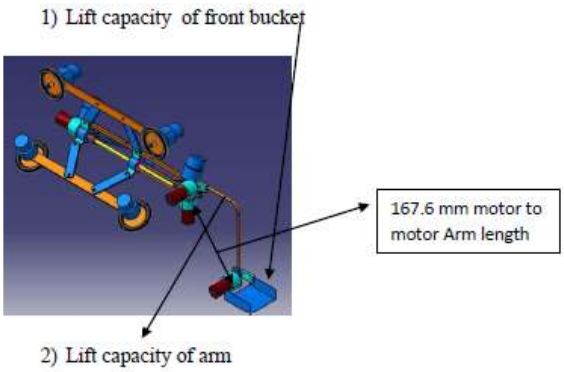
1) Torque (T) =W×L

= 0.75×9.81×0.018

= 0.8324 N-m. The torque is 0.8324 N-m hence choose cutter motor having actual torque is 1.17 N-m

3.3 ARM CALCULATIONS

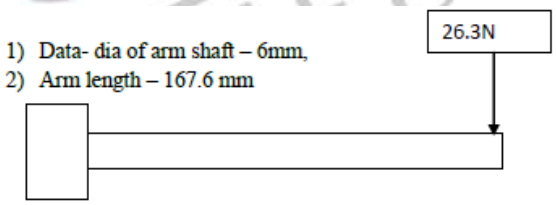
Note- total lift capacity of arm will be defined in 2ways



1. Lift capacity of front bucket
2. Lift capacity of arm

1) Lift capacity of Front bucket by motor used,
167.6 mm motor to motor Arm length
Selected is 10 Rpm, 36Kg-cm or 0.36 Kg-m
Hence use full is 0.36Kg-m, the C.G of the bucket is .07m far from motor shaft,
Hence lift capacity of bucket motor will be
$=\frac{.36\ \text{Kg}-\text{m}}{.07\text{m}}$
=5.1428Kgs
2) Arm lifting capacity by motor used,
Selected is 10 Rpm, 45Kg-cm or 4.14 N-m
Hence use full is 4.14N-M; the length is 167.6mm or 0.1676m from motor shaft,
Hence lift capacity of bucket motor will be
$=\frac{4.14\text{N}-\text{m}}{.167\text{m}}$
= 26.3N or 2.41Kgs

3.4 DESIGN OF SHAFT:
Shear stress of mild steel = 96MPA or 96×106 N/mm2, Torque=4.411 N-m
Shear stress (τ) = $\frac{16\times T}{\pi\times d^3}$
$96\times106 = \frac{16\times T}{\pi\times d^3}$
d=.00601m or 6mm
CALCULATE THE BENDING STRESS:
1) Data- dia of arm shaft – 6mm,
2) Arm length – 167.6 mm



Bending Moment (Mb) = F×L
= 26.3 ×0.1676
= 4.04 N-m
Bending Stress== = 0.930 N/mm2 or 930.6 N/m2
3.5 DESIGN OF LEAD SCREW:
The Torque of the screw driving motor is
T-9.6Kg-cm, 0.941N-m
F-Force in N,
Screw used to drive is M8x1.25pitch
P-pitch in m, (1.25mm, 0.00125m)
Efficiency- η in % for screw it's around 30% to 40% only
Hence $F=T \text{ x } 2 \text{ x } \pi \text{ x} \frac{.3}{p}$
$0.096 \text{ x } 2 \text{ x } \pi \text{ x} \frac{.3}{p}$
F = 1.412 KN from lead screw to grip the pipe surface.

3.6 CALCULATE THE STRESS IN LINKS:

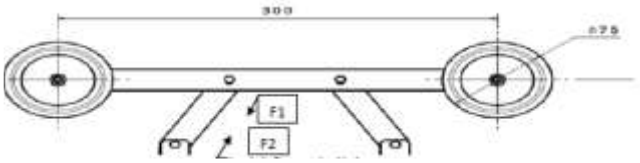


Figure.4.1 Stress in link

As we aware of the force exerted by the screw rod through motor is 1.412KN, it will be shared to 6 links, hence final force will be$\frac{1.412}{6}$ =0.235KN,its the maximum stress it can offer, if we hold for maximum time, so F1 is force from screw rod its 0.235KN, F2 is resistance offered.

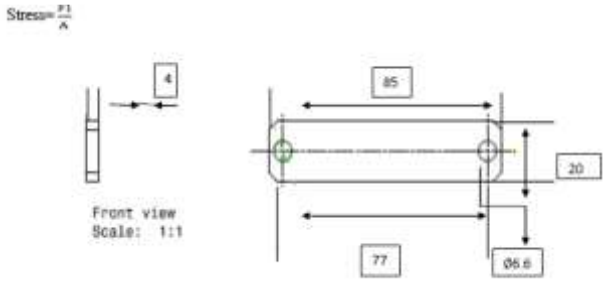


Figure.4.2 link calculation

A-area of link in mm^2, A= 20x4 = $80mm^2$ or 80 $x10^6m^2$

F1-0.235KN,

Stress= $\frac{F1}{A} = \frac{0.235KN}{80\ x10^6m^2} = 29.43N/m^2$ or $0.3kgf/mm^2$

Note-safe is up to $7.5kgf/mm^2$,

Factor of safety = $\frac{\text{Allowable stress}}{\text{Applied stress}} = \frac{7.5}{0.3} = 25$

3.7 MOTORS POWER UTILIZATION:

Table 2.2 Power utilization

Sl no	Motors used	Voltage-V DC	Current in amp	Power in watts
1	60Rpm	12	0.24	2.88
2	60Rpm	12	0.24	2.88
3	60Rpm	12	0.24	2.88
4	60Rpm	12	0.24	2.88
5	60Rpm	12	0.24	2.88
6	60Rpm	12	0.24	2.88
7	300Rpm	12	1.4	16.8
8	300Rpm	12	1.4	16.8
9	10Rpm	12	4	48
10	10Rpm	12	4	48
11	10Rpm	12	4	48
			Total power in watts	**194.88**

IV. MODELLING OF OPEN CHANNEL DRAINAGE CLEANING AND PIPE CRAWLING MACHINE

4.1 CONCEPTUAL MODEL OF OPEN DRAINAGE CLEANING MACHINE

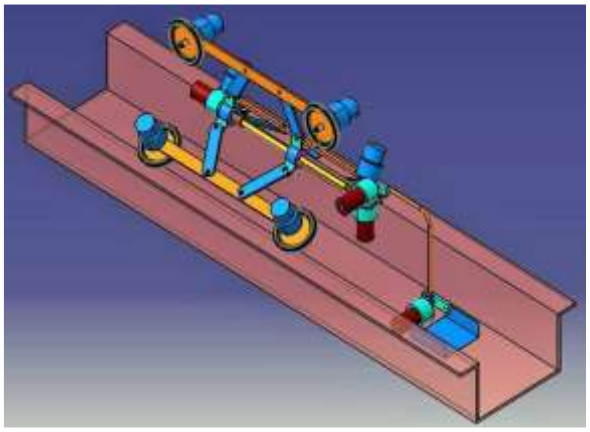


Figure.4.1 Open channel drainage cleaning machine

4.2 CONCEPTUAL MODEL OF PIPE CRAWLING MACHINE:

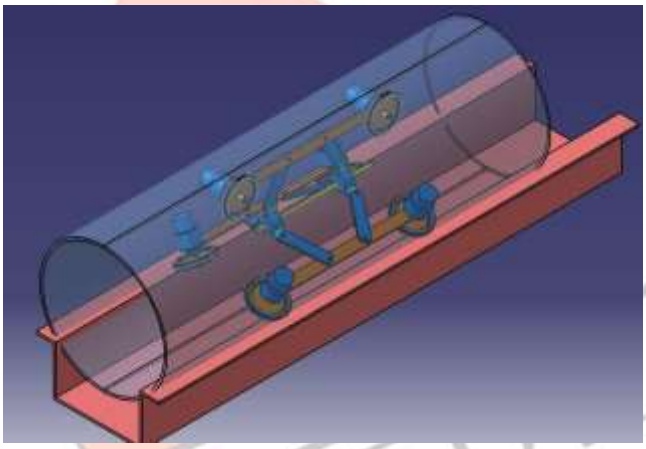


Figure.4.2 Pipe crawler

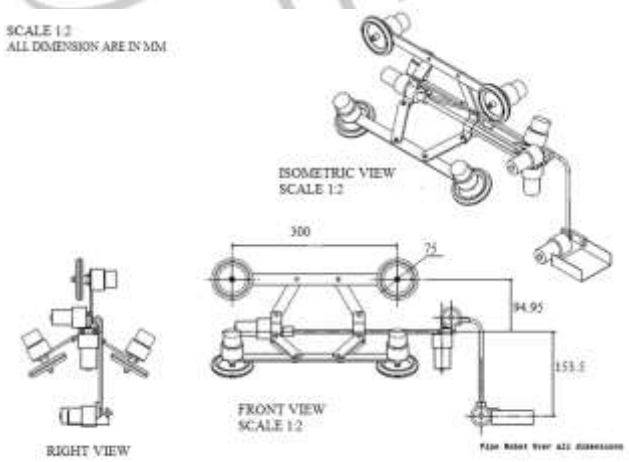


Figure.4.3 Modeling of Open channel drainage machine

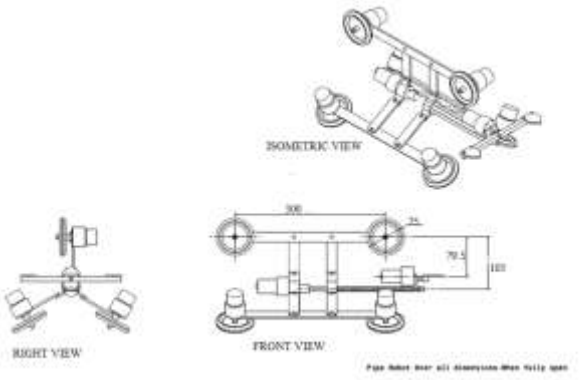


Figure.4.3 2d drafting of pipe crawling machine

V. FABRICATION AND CONSTRUCTION OF MACHINE

5.1 SPIDER NUT:

Figure.5.1 Spider Nut

Spider nut is made up of A36 steel material; it helps to support the whole assembly of an spider. It holds lead screw and screw shaft for shrinkage and elongation of a spider assembly with the help of links. The extended part of a nut is welded to nut. It symmetrically holds the links by the extended part of a nut. By using this nut to hold the motor assembly of an arm with the help of screw shaft

5.2 MOTOR SIDE NUT:

Figure.5.2 Motor side nut

Side nut is made up of A36 steel material; it helps to support the whole assembly of an spider. The side nut is holds the motor by using bush and a grub screw is helps to lock the motor in the nut, it also holds links of an spider assembly for an elongation and shrinkage of an spider by using lead screw.

5.3 LINK-1:

Figure.5.3 Link1

Link1 is made up of A36 steel material, it helps to support the whole assembly of an spider, and it also hold the 60rpm motor is used to drive the wheel at both end side of an link1, and this link1 is connected to the link2 by using nut and bolts for shrinkage and elongation of an spider assembly, there are three quantity of link1 is used in the spider assembly.

5.4 LINK2:

Link2 is made up of A36 steel material, it helps to support the whole assembly of an spider, they require 6 quantity, and this link2 of an one end hold the link1, and the other end connected to the motor nut and a screw nut of each side helps to shrinkage and elongation of an spider assembly.

Figure.5.4 Link2

5.5 LEAD SCREW ROD:

Lead screw rod is made up of carbon steel material, it helps to support the whole assembly of a spider, it is the main part of a spider assembly and this lead screw rod is driven by a high torque motor by using bush. By this lead screw is used to shrinkage and elongation of an assembly with adjustable size.

5.6 SCREW SHAFT:

Screw shaft is made up of carbon steel material, it helps to support the whole assembly of a spider, they are 2 quantity of screw shaft is require to holds the arm assembly and it also guide the screw. It is connected to the nut.

5.7 BUSH:

Bush is made up of A36 steel material, it helps to support the whole assembly of an spider, the main purpose of the bush is to avoid the vibration of an lead screw driven by a motor. it is connected to the motor side nut of an spider assembly for the elongation and shrinkage of an spider assembly.

5.8 MOTOR PLATE:

Motor plate is made up of A36 steel material, it helps to support the whole assembly of a crawler, it holds the screw rod shaft and a 10rpm motor in x-direction to drive the crawler assembly inside the pipe. The 10rpm motor is lock by grub screw in the motor plate. It place vertical to the screw shaft.

5.9 SCREW PLATE:

Screw plate is made up of A36 steel material, it helps to support the whole assembly of an arm, it holds the screw rod shaft and a 10rpm motor in y-direction to drive the arm assembly for movement the arm in left and right direction by using joystick.

5.10 PLATE1:

Plate1 is made up of A36 steel material; it helps to support the whole assembly of an arm, it holds the both horizontal and vertical motor of an arm motor. These motor are locked by a grub screw in a plate1. By using this plate, arm can rotate up and down, left and right direction.

5.11 SIDE PLATE:

Side plate is made up of A36 steel material, it helps to support the whole assembly of an arm, and this plate holds the rod of the arm at one end of the x-direction motor for up and downward direction of arm rod to lift the bucket by using joystick.

5.12 SHAFT PLATE:

Shaft plate is made up of A36 steel material, it helps to support the whole assembly of an arm and a bucket, and it holds the motor in x-direction for up and downward moment of a bucket. The motor is locked by a grub screw in a shaft plate.

5.13 BUCKET:

Bucket is made up of A36 steel material, it is connected to the shaft plate for loading and unloading the unwanted things in the open drainage by using motor and this bucket can be operated by joystick for loading and unloading the unwanted things in the open drainage. And this bucket is used lift the load. By using motor the bucket can be operated in horizontal and vertical movements. This bucket is having rectangular shape looks like 'c' shape.

5.14 BLADE:

Blade is made up of A36 steel material; it is connected to the both end of the square rod. This blade is used to remove the obstacles in the pipe with the help of motor and a square rod by using joystick.

5.15 SQUARE ROD:

Square rod is made up of A36 steel material, it helps to support the whole assembly of an crawler, the square rod with blades is rotated 3600 inside the pipe by using 300rpm motor to remove obstacles by using joystick.

Figure.5.5 working model of open channel drainage cleaning machine

Figure.5.6 working model of pipe crawling machine

VI. RESULT

- It is successfully fabricate a pipe crawling cleaning machine by which it is possible to remove the obstacle inside the pipe in 0.5m in 20 sec.
- It is successfully fabricate an open channel drainage cleaning machine by which it lifts 300gm of wastage to clean the open channel drainage.

VII. CONCLUSION

The pipe crawler effectively remove obstacle inside the pipe, it is used for industries for inspection purpose, it is suitable for adjustable pipes for remove obstacle inside the pipe. In this open channel drainage cleaning and pipe crawling machine is easy to operate by using switch board and easy to maintenance, the following results are obtained:

- It is successfully fabricate a pipe crawling cleaning machine by which it is possible to remove the obstacle inside the pipe in 0.5m in 20 sec.
- It is successfully fabricate an open channel drainage cleaning machine by which it lifts 300gm of wastage to clean the open channel drainage.

Hence the machine concludes that, it reduces 120-180 sec of time for cleaning open channel drainage and pipe compare to manual work. It eliminates the problem of hand infection and other causes. It reduces the labour problem for cleaning drainages and pipe.

VIII. SCOPE OF FUTURE WORK

- It can be developed for a real environment, in order to reduce the labour problem for cleaning pipes and open channel drainage.
- Using hydraulic and pneumatic system adopting for open channel drainage cleaning machine to effectively clean the drainage
- Real environment model helps to corporation and municipalities to clean the open channel drainage.

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