Factors Affecting Lifespan of Primary Screen and it's Solution in Sand Screener

Rishi Patel[1], Tirthkumar Brahmbhatt[2], Valmik Patel[3], Uday Patel[4]

[1,2,3,4]*Students, Dept. of Mechanical Engineering, Government Engineering College, Patan, Gujarat, India*

---***---

Abstract - *Sand screening machine is a machine designed to separate the particles according to their mesh size with the help of different level of separating screens. Efficiency of vibrating screen basically depends on various factors such as amplitude of vibration, material loading, screen material. We have developed a conceptual model of a inclined vibrating screen to remove heavy stones (grater than 60 mm) and capable to increase the life span of primary screen which is damaged by impact load of raw material. So Outcome carried away by simulation with modelling software NX 9.0 and analysis software NX Nastran is as per requisite result.*

Key Words: **sand screening and washing process, primary screen, vibration, NX Nastran**.

1. INTRODUCTION

Firstly raw sand coming directly from river bed gets unloaded inside the hopper having capacity of 40 tone. There is vibro-feeder under hopper which help in feeding raw sand from hopper to conveyor belt. Raw sand gets into primary screen. Primary screen is having size of 6 mm steel grid is fitted , also having two 5 hp motor which helps in producing vibrations in primary screen and due to which sand having size less than 6 mm is sorted and oversized material is taken out.

1.1 SAND SCREENING AND ITS NEED

Sand screening is the method for separating comparatively larger sand particle and other unnecessary impurities present in the sand which is dug from river bank. Screening is the requisite process. It is required that Gravels and pebbles are removed from the sand. Due to screening of sand, we can give good strength to the concrete and improve quality of sand.

As per constructional requirement in concrete, there is no content of clay. Due to clay content, quality and strength of concrete is weak.

Foreign body contamination is unnecessary material that differs from the sand going over and through the screen. It can be anything ranging from grass, tree twigs, clay, and metal slag to other mineral types and composition. This contamination occurs when there is a hole in the screen mesh or a foreign material's mineralogy or chemical composition differs from the sand.

Fig.1 Primary Screen

1.2 MECHANISM FOR SCREENING

In this mechanism vibrating equipment is a shaker or a series of shakers as to where the eccentric motor connected via belt pulley transmission to rotating shaft causes the whole structure to shake. Due to amplitude of vibration, material is up and down and due to inclination material moves forward. Four springs are situated below the structure to where there is vibration and shock absorption as the structure returns to the middle state.

1.3 PARTS

- Hopper:- Hopper can be used for storage and inlet for raw sand.
- Screening mesh:- Screening mesh is provide for screening the sand having size according as per requirement.
- Spring:- Spring is used for prescribed motion causing the mass to vibrate.
- Motor:- electric motor is used for provide rotation to the shaft at a certain RPM.

- Shaft :- Shaft rotates according to motor and helps to transmit this motion to screening net.

2. PROBLEM IDENTIFICATION

We had visited company and see their machine of sand screening system. As the raw sand coming from the river does not have any fixed particular size. It is having large sized material with it. When the material is taken from hopper to primary screener which is at certain height through a conveyor belt. The raw sand impacts directly on primary screen which is made from 1 mm diameter wire of stainless steel (SS) and mesh size 6 mm . Due to this direct impact, it damages the primary screen & leads to frequent changing of primary screen. So, it leads to more maintenance as well as it becomes time consuming too & during those hours plants needs to be shuted off. All the production based industries wanted low production cost and high work rate which is not fulfill.

Fig 2. Heavy stones in primary screener

3. DESIGN AND CALCULATION

The design with detail things including dimension done with NX 9.0. we need durable , impact shock resistant , abrasive . So the cost of design is reduced and fabrication is easy.

Design of Spring :-

From, V.B.Bhandari DDB

Material :- cold drawn steel wire

Ultimate tensile strength :- 1090 N/mm^2
Modulus of rigidity :- 81370 N/mm^2

- Wire diameter :-

$$\tau = K\left(\frac{8PC}{\pi d^2}\right)$$

$$d = 13.89\ mm \approx 14\ mm$$

- Number of active coils

$$\delta = \frac{8PD^3N}{Gd^4}$$

$$N = 2.63 \approx 3$$

It is assumed that the spring has square and ground ends . the number of inactive coils is two. therefore,

Total no. coils N_t = N+2 = 3+2 = 5 coils

- Free length of spring

Free length = Solid length + total axial gap + d
= 70 + 2 + 29.57
= 101.57 mm

- Required spring rate

$$K = \frac{P_1 - P_2}{\delta}$$

$$K = 275\ N/mm$$

- Actual spring rate

$$K = \frac{Gd^4}{8D^3N}$$

$$K = 219.75\ N/mm$$

- Pitch of coil

$$pitch\ of\ coil = \frac{free\ length}{N_t - 1}$$

$$= 25.39mm$$

Spring specifications :-

Wire diameter	14mm
Mean coil diameter	84mm
Number of active coil	3
Total number of coils	5
Solid length of the spring	70mm
Free length of spring	101.57mm
Pitch of the coil	25.39mm
Required spring rate	275N/mm

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

(stiffness)	
Actual spring rate (stiffness)	219N/mm

Design for shaft

Power = 2.2 kW
Speed= 332 rpm

$$P = \frac{2 \times \pi \times N \times T}{60}$$
$$T = 63.3\ N/mm$$

Diameter of pulley of motor D_1 = 80 mm
Diameter of pulley of shaft D_2=200 mm

- Speed of shaft $N = \frac{60 \times \omega}{2\pi}$

$$N = 332\ rpm$$

- Speed of motor N_1

$$\frac{N}{N_1} = \frac{D_1}{D_2}$$

$$N_1 = \frac{332 \times 200}{80}$$

$$N_1 = 830\ rpm$$

- Reduction ratio

$$\frac{830}{332} = 2.5$$

- Shear stress 84 MPa for plain carbon steel

$$T = \frac{\pi \times \tau \times D^3}{16}$$

$$D = 21.2 \approx 25mm$$

Calculation for shaft speed

Amplitude of forced vibration

$$X_{max} = \frac{F}{\sqrt{C^2\omega^2 + (S - m\omega^2)^2}}$$

Here no damper, so C=0

We assume X = 10 mm
$\delta = 20\ mm$
m = 300 kg

$$X = \frac{F}{S - m\omega^2}$$

$$\omega = 34.76\ rad/sec$$

Inclination of vibrating screen
As per the theory of angle of repose

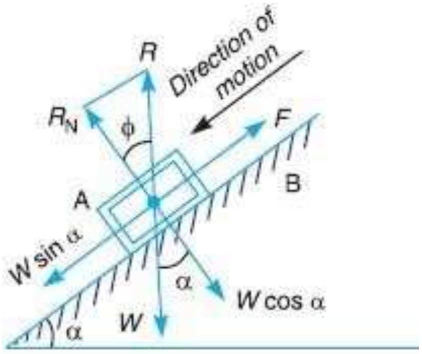

Fig 3. Angle of repose

$$\alpha = \emptyset$$
$$\tan\emptyset = \mu_s$$
$$\alpha = \tan^{-1} 0.25$$
$$\alpha = 14$$

4. CAD MODEL AND ANALYSIS

CAD Model is the virtual prototype of the model. It gives us the enough information about the working criteria of the system.

List of the Components

1. Hopper
2. Screener
3. Helical spring
4. Shaft
5. Support

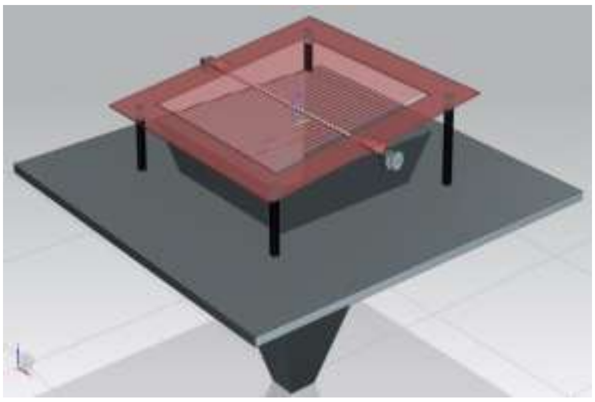

Fig4. CAD model of the assembly

We have created proposed cad model for our design is created with the help of NX 9.0 .

ANALYSIS :-

SPRING :-

Analysis type	Structural analysis
Load	2500 N
Solver	NX Nastran

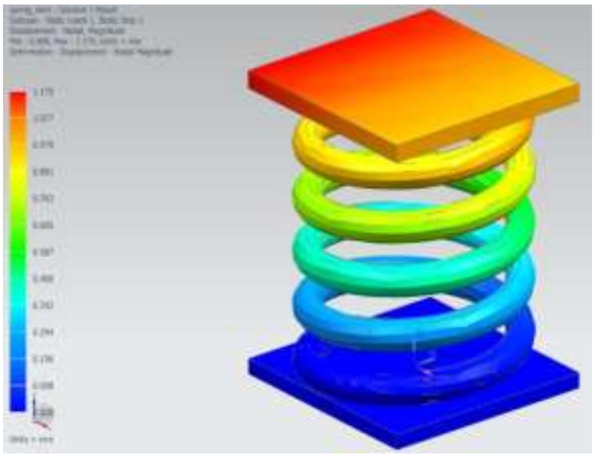

Fig 5. Structural analysis on spring

From the analysis results , we can conclude that the design of the spring for 2500 N is safe. Factor of Safety is 2.

SCREENER:-

Analysis type	Structural analysis
Load	10000 N
Solver	NX Nastran

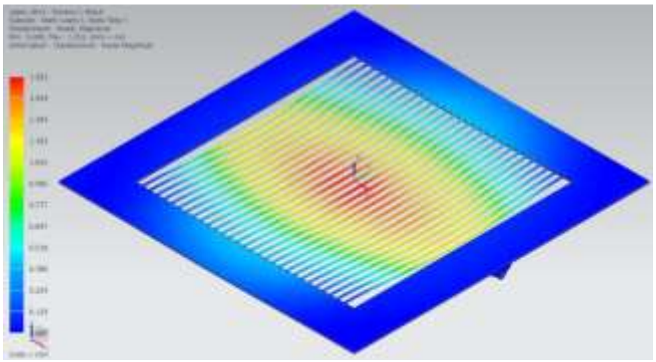

Fig. 6. Structural analysis on screener

From the analysis results , we can conclude that the design of the screener for 10000 N is safe. Factor of Safety is 2.

5. CONCLUSION

In this study, the primary screen mesh failure problem encountered by impact load due to large stones successfully addressed by applying inclined vibrating screen.by removing large stone before primary screen , that increase the lifespan of the primary screener. The maintenance cost is also reduced. The quality of the sand after screening is uniform. Also the critical components were identified as namely a spring and screen. Both parts were designed by either theoretical method and then static structural analysis using NX Nastran , both parts were found to be safe as the actual stress induced by both methods was far below the allowable value.

ACKNOWLEDGEMENT

We feel great pleasure to present the dissertation entitled **"Factors Affecting Lifespan of Primary screen and it's Solution in Sand Screener"** but it would be unfair on our part if we do not acknowledge efforts of some people without the support of whom this dissertation work would not have been success. First and for most we are very much thankful to our respected guide **Prof. Bhargav B Patel** for his leading guidance in this work also he has been persistent source of inspiration to us . we would like to express our sincere thanks and appreciation to **Mr. Piyush Hedaoo** for provide support in analysis work . most importantly we would like to express our sincere gratitude towards our friends and family for always being there when we needed them most

REFERENCES

[1] *Vaibhav V. Patil, Sandeep Raut "Sand Screening And Washing Machine" Vol 2 Issue 9 September, 2013 ISSN: 2278 – 0211 (Online)*

[2] *Salunkhe Prashant, Saurabh Naik, "Study of Design of Multilevel Vibration Screening Machine" 23rd MARCH 2016, ISBN: 978-81-932074-7-5*

[3] *Swapnil Bandgar, Dnyaneshwar Chate, "Review of multi-level sand screening machine and analysis of vibration mechanism", Vol-4 Issue-3 2018, IJARIIE-ISSN(O)-2395-4396*

[4] *Gunaji sawant, V. Murali mohan, "Review paper on factors affecting efficiency of vibration screen", Volume II, Issue III, ISSN No: 2350-1146, I.F-2.71*

[5] *Mr. Pranit S. Patil1, Mr. Shubham. S. Jagadale, "Multipurpose Sand Screening Machine", Vol. 4, Special Issue 1, January 2017, ISSN (Online) 2393-8021*

[6] *Gunaji Ashok Sawant[1] V. Murali Mohan, "Study and Analysis of deck inclination angle on efficiency of vibration screen", Volume 4, Issue 1 | ISSN: 2321-9939*

[7] *Pawar Santosh R. , Daunde Suyog A., "Cam And Follower Operated Multi-Level Vibrating Screening Machine", Volume:4 Issue: 4 | April 2017, e-ISSN: 2395-0056*

[8] *A.K. Nachimuthu, S.Ragunath, "Design And Fabrication Of Horizontal Sieving Machine", Volume: 01 Issue: 03 | July -2016, ISSN : 2455-930X*

[9] D P Jadhav, Harishchandra Ekal, Design & Fabrication of Multi-level Screening Machine", Volume-5, Issue-3, 2018, E-ISSN: 2349-7084

[10] M.Ramarao 1, B.Mahesh, " Design and Fabrication of Development of Sand filter and Separator Pedal Powered", Volume 6, Issue 3, March (2018), ISSN: 2454-6410

[11] Gunaji sawant, V. Murali mohan, "Dynamic Analysis Of Vibration Screen", Volume 2 | Issue 06 | November 2015, ISSN (online): 2349-6010

[12] Bhandari V. B., Design of machine elements, eighteenth edition, MC graw-hill Companies, 2003

[13] Khurmi R. S., Gupta J. k., A textbook of Machine design, first edition, S. chand publication, 1979.