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Design and Development of Screw Conveyor for Micro Silica

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Abstract: ***The concrete is the most extensively used construction material in the world. Now a days the cost of the building materials is increasing and availability of the material is decreasing. Due to the production of cement CO2 emission is also increasing. To overcome all these, the cement is partially replaced by the supplementary materials like Micro Silica, Meta kaolin, Fly-ash, Ground Granulated Blast Furnace Slag (GGBS) etc. In this work, micro silica is used for partial replacement of cement. Micro Silica is a by-product obtained from Silicon and Ferro Silicon alloy industries. Split tensile strength tests on concrete are conducted with partial replacement of cement with various percentages of 0%, 10%, 12.5%, 17.5%, 20%, and 22.5% of micro silica. Thus concrete cylindrical specimens were prepared, cured, tested and compared in terms of split tensile strength. From the obtained results it is concluded that the maximum split tensile strength is attained at 12.5% replacement of cement with micro silica***

Keywords: ***Concrete Cement replacement, Micro silica, Supplementary materials, Cost-effective construction, Sustainable building materials, CO2 emissions, etc***

I. INTRODUCTION

Screw conveyors are one of the oldest and simplest method of moving bulk material and consist primarily of a conveyor screw rotating in a stationary screw rotating in a stationary trough. Conveyor find application in mostly in predicative factorizes where transportation is fairly of continuous and uniform character, the individual loads being very thigh. Screw conveyors are compact, easily adapted to congested locations and Screw conveyors are compact, easily adapted to congested locations and can be mounted horizontally, vertically and inclined. Their supports are simple and easily can be mounted horizontally, vertically and inclined. These versatile conveyors can be used to control the flow of material in these versatile conveyors can be used to control the flow of material in processing operations which depend upon accurate batching or as a mixer, agitator or processing operations which depend upon accurate batching or as a mixer, agitator or stirrer to mix and blending dry or fluid d ingredients provide crystallization or coagulation action or maintain solutions in suspension. Screw conveyors can be effectively sealed to prevent dust or fumes from Screw conveyors can be effectively sealed to prevent dust or fumes from escaping or dirt or moisture from entering. They can be jacketed to serve as a dryer or cooler, or furnished in a wide variety of materials to resist corrosion, abrasion variety of materials to resist corrosion, abrasion or heat. Screw conveyors are used as a earth augers to dig past holes or to bore Screw conveyors are used as a earth augers to dig past holes or to bore under highways for installation of culverts. They are also used extensively on threshing-under highways for installation of culverts. They are also used extensively on threshing machines hay balers fodder blowers and many other farm machines. Micro Silica is a pozzolonic material which is environmentally stable and proven itself as good to use all over the world since 1900. It is a industrial by product of high purity quartz industries and ferry-alloy industries. Generally, size of micro silica varies from 10nm to 1000nm. First test of silica fume in concrete is done in 1952. The use of micro silica in concrete become prominent from 1970.

II. GOAL

This manual is helpful in designing of screw conveyors using calculations in metric. This manual is helpful in designing of screw conveyors using calculations in metric units.Saving of labour and time.To increase the output:With the help of conveyors more work can be done with a given floor space, blocks are With the help of conveyors more work can be done with a given floor space, blocks area voided.To utilize existing building for new purposes: Conveying plant enables two or more detached building to be connected together and Conveying plant enables two or more detached building to be connected together and used for several operations in proper sequence. Reducing personal hazardous: The enclosing trough can be made tight enough to contain toxic dust and pours.

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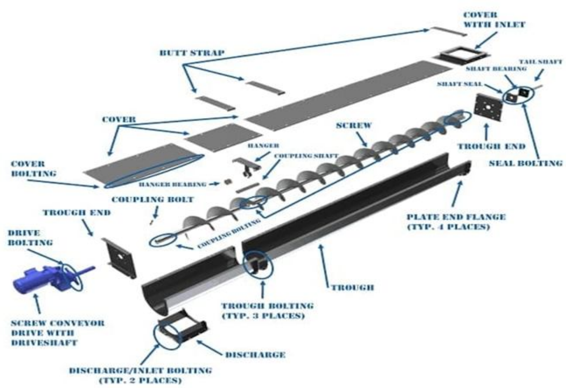
The enclosing trough can be made tight enough to contain toxic dust and vapours.Material in transit can be heated or cooled by jack Material in transit can be heated or cooled by jacketing the trough.The aim of this project is to "design and fabricate a screw conveyor" to convey cement.

III. ADVANTAGE

It can handle different types of material types. It can be slow or free flowing.There are multiple inlets and outlets, which can discharge materials at various points required, and can also control the flow of materials with the help of sliding doors or valves.They are adjustable and can be accommodated in smaller spaces.Screw conveyors are used in some industries to mix various materials and break clumps.The custom screw conveyor without a central shaft (i.e., shaft less screw conveyor) can be used for conveying wet, slow and viscous materials in the industry.The screw conveyor can also help to heat, cool or dry the material, internal pressure and steam can be maintained. This is very important when we are dealing with toxic or hazardous materials.The auger screw conveyor is easy to install and safer when working in a higher position.

IV. EXPERIMENTAL SETUP OR DIAGRAM



A. *Component*

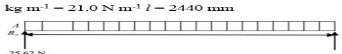
1) Conveyor screw
2) Bearings
3) Coupling bolts
4) Shaft seals
5) Discharge
6) Shafts
7) Trough end
8) Conveyor
9) Plate end flange
10) Slide gates

B. *Calculation*

The bending stress "σ_b" of the shaft was calculated using Equation (1) (Khurumi and Gupta, 2004) for hollow shaft:

$$\sigma_b = \frac{32BMd_o}{\pi(d_o^4 - d_i^4)}$$

where σ_b = bending stress (N m^{-2}); BM = bending moment (N m); d_o = outside shaft diameter (mm); d_i = inside shaft diameter (mm); π =3.142 (constant). To obtain bending moment "BM" $q = 2.14$ kg m^{-1} = 21.0 N m^{-1} $l = 2440$ mm



For uniformly distributed load (UDL)

If reaction at $A=R_a$ and at $B=R_b$

$$R_a + R_b = ql \qquad (2)$$

where, q = weight of the material; l = length of the shaft.

$$ql = 21.0 \times 6 \text{ N/m}$$

$$BM = \frac{21.0 \times (6.096^2)}{8} = 97.54 \text{ Nm}$$

$BM = 97.54$ N m

From Equation (1)

$$\sigma_b = \frac{32BMd_o}{\pi(d_o^4 - d_i^4)}$$

$= 32 \times 97.54 \times 0.168 / 3.142$

$(0.168^4) - (0.028^4)$

$= 209.69 \times 10^3$ N/m^2

$d_o = 0.168$ mm = 168 m

$d_i = 0.028$ mm = 28 m $\pi = 3.142$

Torsional control

$$\text{Angle of twist} = \frac{TXL}{GXT} \qquad (4)$$

where, T = Torque or torsional moment (N m); L = Length of the shaft (m); G = Modulus of rigidity of the shaft (N m^{-2}) (Khurmi and Gupta, 2004).

$$\text{Torsional moment, } T = \frac{2TXJ}{D}$$

But $R_a = R_b$

And $R_a = (ql)/2$ and $R_b = (ql)/2$

$R_a = 21.08 \times 6.096 / 2 = 64.008$ N

But 2.44 m $R_a = R_b$

Since the system is an UDL

$R_b = 64.008$ N

To obtain bending moment "*BM*" for Equation (3)

Hibler (2002)

$$BM = \frac{ql^2}{8}$$

(k = 1.05-1.2); L_y = length of the conveyor = 2.44 m, H = perpendicular height = 1.840 m; g = acceleration due to gravity = 9.81 m s^{-2} (Ruina and Pratap, 2010).

From Equation (9)

$$P = 30 \times 9.81(6.096 \times 2.7 + 8) 1.2 = 8.638 \times 10^3 \text{ W}$$

Therefore for safety factor the driving power "*P*" is taken to be 90 watt.

2.7 Driving force of the conveyor

If the conveyor must function, the angular moment is expected to be directly proportional to the angular force which should be greater than the required driving force.

where, M_w = Angular moment; d_i = Diameter of screw where the bulk of the materials moves (m); Q = Pitch angle, $R = 23°$; B = Frictional angle for the whole screw (°) (Ruina and Pratap, 2010).

J = Polar moment of inertia of the cross section area about the axis of rotation (Nm^{-2})

$$\text{But } J = \frac{\pi(d_o^4 - d_i^4)}{32} \text{ (for Hollow shaft)} \quad (6)$$

$$T = \pi X J X \frac{(d_o^4 - d_i^4)}{16 X D}$$

where, J = maximum shear stress (according to ASME code is 53 × 10^6 N m^{-2}); π = 3.142; D = Diameter of the shaft (m); d_o = outside diameter of the shaft (m); d_i = inside diameter of the shaft (m) (Khurmi and Gupta, 2004).

$$T = \frac{3.142 \times 7.814 \times 10^{-5} \times (0.168^4 - 0.028^4)}{16 \times 0.196}$$

$T = 6.227 \times 10^{-8}$ N m

where, S = Pitch of the auger = 0.031 m s^{-1}; V = 0.125 × 3.142 = 0.3925 m s^{-1} From Equation (14)

$$q_m = \frac{0.8333}{0.09740} = 8.56 \text{ kg/m}$$

Therefore

Actual q_m = 8.56 × 2.44 = 20.88 kg From Equation (13)

$$M_w = \frac{20.88}{2 \times 3.142 \times 1.5} = 2.2151 \text{ Nm}$$

$$F_w = \frac{2 \times 2.2151}{110 \tan(23^0 + 20.81^0)} = 0.04198 \text{ N}$$

Magnitude of the driving force "F_0" was determined using the Equation (16)

$$F_0' = q_m(L_x \pm Hf) \cdot g N() \quad (16)$$

where, L_x = length of the conveyor (m); H = vertical height (m); f = coefficient of friction; g = acceleration due to gravity (m s^{-2}).

therefore

$$F_0' = 8.56(2.44 + 1.84)0.38 \times 9.81 = 136.57 \text{ N}$$

The driving force F'_0 must be greater than the Angular force. i. e. $F'_0 > F_0$

i.e. 136.57 > 0.04198

V. ANALYSIS

When analyzing a screw conveyor for Microsilica, several factors need consideration:

1) Material Properties: Understand the flow characteristics of Microsilica, including its bulk density, particle size distribution, angle of repose, and cohesion. These properties influence how the material flows through the conveyor and impacts its design.
2) Design: Determine the screw conveyor's dimensions, such as diameter, pitch, length, and speed, based on the desired throughput and material properties. Consider factors like the screw's flight configuration and shaft flight configuration and shaft design to minimize particle segregation and ensure efficient material handling.
3) Material Handling, Assess how Microsilica behaves during conveying, including potential issues like material build-up, abrasion, and dust generation. Incorporate appropriate design features, such as wear-resistant materials, sealing mechanisms, and dust collection systems, to mitigate these challenges.
4) Mixing Efficiency: Evaluate the conveyor's role in achieving
5) Uniform dispersion of Microsilica within the concrete mixture. Consider factors like mixing intensity, retention time, and material distribution to optimize the blending process and ensure consistent concrete properties.

6) Operational Considerations: Address operational factors like start-up/shutdown procedures, maintenance requirements, and safety measures associated with the screw conveyor system. Implement proper controls and monitoring systems to optimize performance and prevent potential issues during operation.

VI. RESULT

The result of analyzing a screw conveyor system for Microsilica Involves optimizing its design and operation to ensure efficient handling and dispersion of Microsilica within the concrete mixture. This optimization leads to improved concrete properties, such as enhanced strength, durability, and workability, while minimizing material waste and operational challenges. Additionally, a well-designed screw conveyor system for Microsilica contributes to overall production efficiency and cost-effectiveness in concrete manufacturing processes. Analyzing the use of Microsilica in a screw conveyor system for concrete production typically involves assessing its flow characteristics, particle size distribution, and mixing efficiency. By understanding these factors, engineers can optimize the conveyor design and material handling processes to ensure efficient and uniform incorporation of Microsilica into the concrete mixture. Additionally, they may evaluate the impact of Microsilica on the overall properties of the concrete, such as strength, durability, and work ability, through laboratory testing and simulation studies. The results of such analysis help in fine-tuning the production process to achieve desired concrete performance while maximizing cost-effectiveness.

VII. CONCLUSION

RSM optimization technique was adopted for modelling the fresh and hardened properties of ternary blend concrete to achieve the optimum percent of FA and MS together in concrete mixtures. In this model, three responses (slump and compressive strength at 7 and 28 days) were considered. Based on the ANOVA analysis, it was discovered that the statistical models for slump and compressive strength at 7 and 28 days are highly significant. As lack- of-fit test results and high values of coefficients of determinations (R2) confirmed the accurateness of the second- degree polynomial model to expect the required properties of concrete concerning 7 and 28 days compressive strengths, in addition to the slump value. Optimization of two responses was also performed to achieve a mixture with 80 mm slump and maximum 28 days compressive strength. The achieved results revealed that the optimum values of studied factors were 5.94 and 10% of FA and MS, respectively

VIII. ACKNOWLEDGMENT

We extend our heartfelt gratitude to all those who have contributed to the design and development of the screw conveyor for micro silica. First and foremost, we express our sincere appreciation to [Name of Supervisor/Project Lead], whose invaluable guidance, unwavering support, and expertise have been instrumental throughout this project.

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