A Study about the Erection of the Gearbox and Motor Foundation Frame for the Vertical Roller Mill

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Case Report

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ABSTRACT

The gearbox foundation frame is most important in heavy engineering applications to reduce the vibration level and protect the structures from heavy damage. Maintaining the level of the gearbox and motor frame has significant advantages in reducing vibration levels, and sudden impacts during grinding and also the position and orientation are as important as maintaining its level. Once the gearbox and motor foundation frame have been placed, the elevation reading has to be taken using an auto level, corrections have to be made using the jack bolts and hydraulic jack as required, and then it should be released for full grouting as soon as possible.

Keywords: Gearbox foundation; Motor frame; Hydraulic jack; Jack bolts; Full grouting

INTRODUCTION

The vertical roller mill is widely used for raw material grinding in the cement and power plant industries. It is increasingly being used as a solution for efficient grinding. Vertical roller mills are becoming crucially influential in the cement industry as more cement producers attempt to maximize their use of clinker substitute materials instead of importing clinker to meet significant localized increases in cement demand. The vertical roller mill has many advantages, including high grinding efficiency and low energy consumption. Because of their low installation cost, ease of operation and maintenance, energy efficiency, and product quality, vertical roller mills are an excellent grinding solution for raw materials and cement clinker.

Many clinker grinding applications are now successfully using Vertical Roller Mills (VRMs). In 2002, the Phoenix, Arizona cement plant installed the first vertical roller mill in the United States as part of a larger facility development. When compared to limestone, cement and clinker raw materials are finer and more difficult to crush. The Vertical Cement Mill (VRM) is a two lobed design that de aerates and consolidates the material to form a compact, well established grinding bed for maximum stability [1].

The drive train is only one component of a VRM drive. A strong and cost effective casing design was required to position and support the mill axial and radial bearings. The fourth generation drive, like the third generation drive, had to fit beneath the mills. A compact solution for VRM drives is now available, offering up new possibilities for higher torques, more efficient maintenance, and redundancy. Casting enabled the creation of a structure with a soft load direction. In comparison to a third generation drive, the fourth generation drive was required to fit under the mills with little adaptation [2].

Vertical Roller Mill (VRM) has proved to be a popular choice for finished cement grinding over all other types of machinery. VRM is very prone to vibration if its parameters are varied slightly. High vibration may create break downs and lower efficiency and productivity. The problems of high vibration and low productivity can be addressed using problem solving tools [3].

Vertical Roller Mills (VRM) have mostly found use in cement grinding. They are used in the stages of raw meal and finish grinding as well as coal grinding in power plants. The goal was to create a VRM performance prediction model based on characterization data and knowledge of the interaction of the individual grinding parameters [4].

CASE PRESENTATION

Erection procedure

Cleaning and exposing the insert plates: The first step of the erection procedure was to clean the insert plate's surface. After the elimination of foreign particles, chipping was done to expose the insert plates to a visible condition as shown in Figure 1.

As per the OEM drawing the top of insert plates are maintained at +250 mm and +350 mm from the +0 m level of the foundation for the gearbox frame side and motor frame side.

Figure 1. (a) Gearbox side; (b) Motor side.

Elevation reading: From +0 m level (+71.4 m survey level) +73.4 m (*i.e.*) +2 m level had been marked permanently on each face of 4 pedestals for future reference to take readings. For the +2 m level, readings had been taken on the top of insert plates using an auto level and scale as shown in Figure 2.

Figure 2. Checking the elevation.

Providing packing plate: Concerning the auto level readings to match the foundation frames to 0 m level, packing plate height should be selected. In this work, packing plates of 3 mm X 30 mm is provided as shown in Figure 3. After placing the packing plates they should be welded on the corners and their flatness is checked by using a spirit level as shown in Figure 4. It should be noted that the number of packing plates should be less [5].

C=H (IP)+H (F)+H (PP)

Where C is the clearance to adjust the height, H (IP) is the elevation at top of the insert plate, H (F) is the height of the foundation frame and H (PP) is the height of the packing plates.

Figure 3. (a) Gearbox side; (b) Motor side.

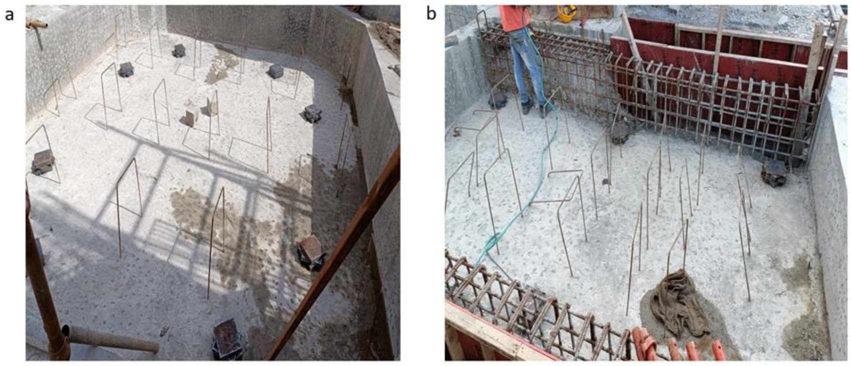
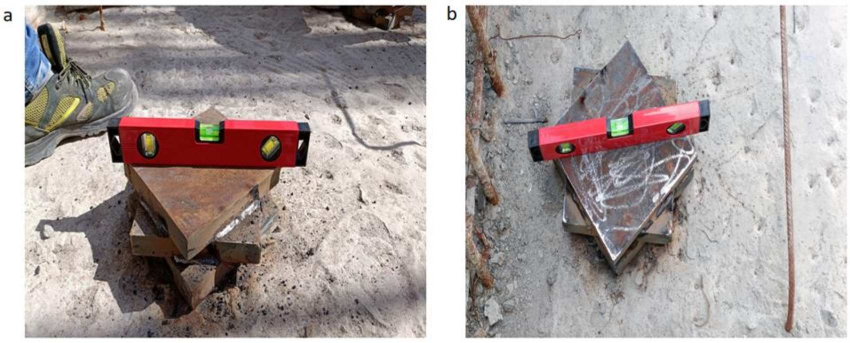


Figure 4. Flatness checking by spirit level.



Inserting jack bolts: Jack bolts are welded with T-shaped rebar to do the adjustment as shown in Figures 5-8. These bolts are to be inserted into the frames before lifting. Once the bolts have been inserted, the frames are lifted by using a crane. It should be noted that frame weight, the height of lifting, working radius, and boom length are most important before choosing the capacity of the crane [6].

After lifting, the jack bolts have to be perfectly sat on the packing plate as shown in Figures 9 and 10, and readings have to be taken on the top of the frame by using scale and auto level to match the +1 m level elevation. Concerning the readings, height adjustments should be made. These height adjustments are to be made within the clearance obtained using the above formula (Tables 1 and 2) [7].

Figure 5. (a) Bolts welded with T-shaped rebar; (b) Bolts inserted in foundation frame.

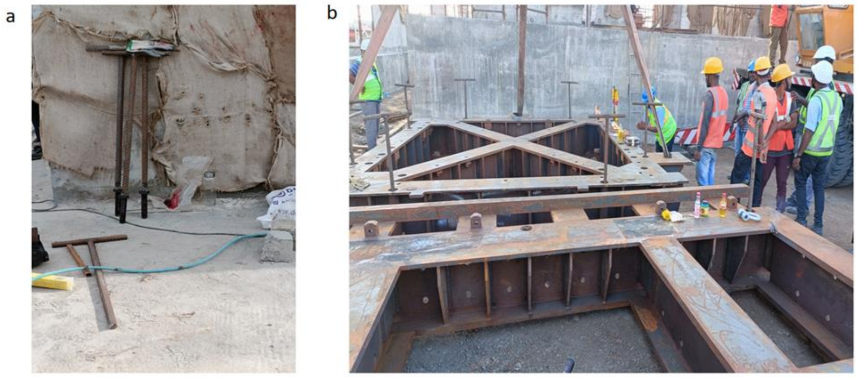


Figure 6. (a) Lifting of gearbox frame; (b) Lifting of motor frame.

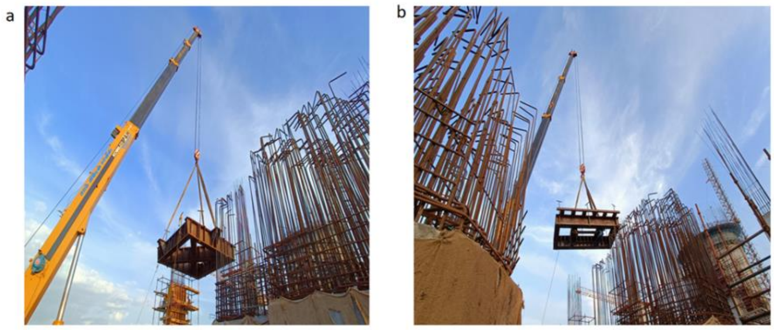


Figure 7. Measured points on motor foundation frame.

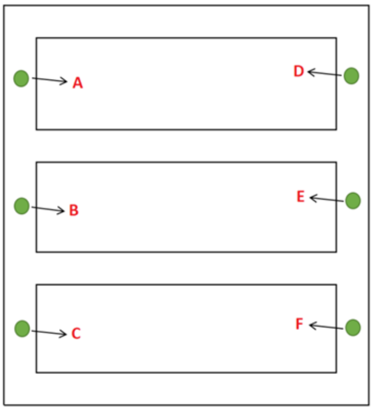


Table 1. Motor foundation frame readings.

Points	Before placement (mm)	After adjustment (mm)
A	1392	1000
B	1392.5	1000
C	1392	1000
D	1392	1000
E	1391	999.5
F	1392	1000

Figure 8. Measured points on gearbox foundation frame.

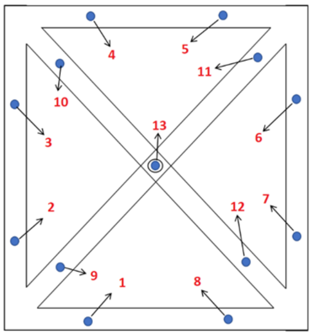


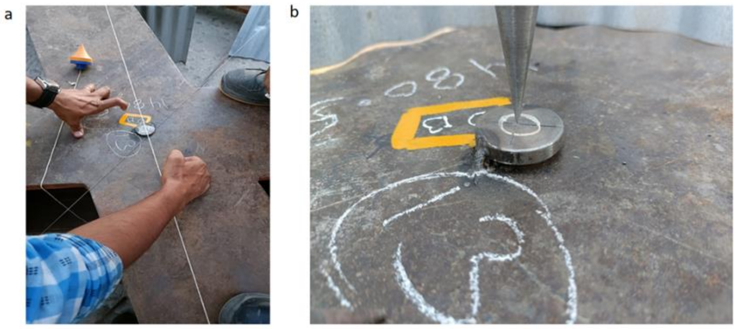
Table 2. Gear box foundation frame readings.

Points	Before placement (mm)	After Adjustment (mm)
1	1392	1000
2	1392	999.5
3	1392.5	1000
4	1392	1000
5	1391	1000
6	1391	1000
7	1391.5	1000
8	1392	1000
9	1393.5	1000
10	1393.5	1000
11	1393	1000
12	1393.5	1000
13	1394	1000

Marking the center and frame alignment: A new bush has been inserted on the frame's center hole to check to mark the mill center line permanently to take reference from the center for future alignments. The frame center was checked with the plumb and if any adjustment is required on the X and Y axis it should be made by using a hydraulic jack [8].

Figure 9. (a) Placing gearbox frame; (b) Placing motor frame.

Figure 10. (a) Center line checking using piano wire; (b) Center checking using plumb.



Cross checking and locking: Once the alignment has been completed, it should be cross verified using a total station survey instrument including diagonals, X, and Y centers as shown in Figure 11. After checking the frames should be locked by using a piece of I-section beam, channel, or angle by anchoring a plate on the bottom as shown in Figure 12.

Figure 11. Cross checking the center line and diagonals using total station.

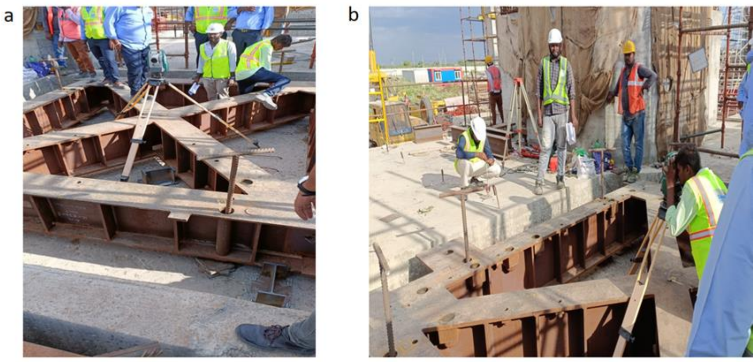
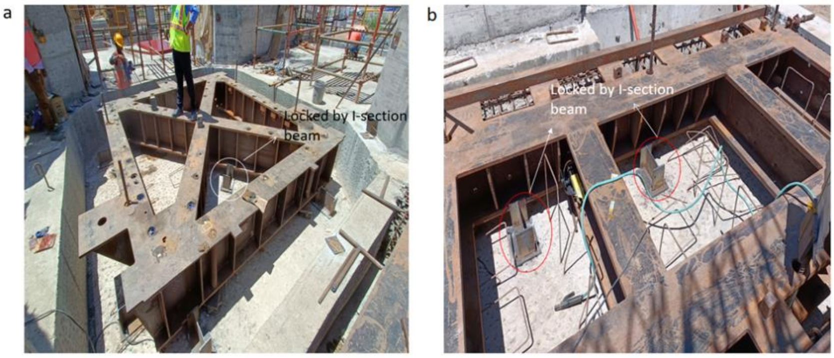
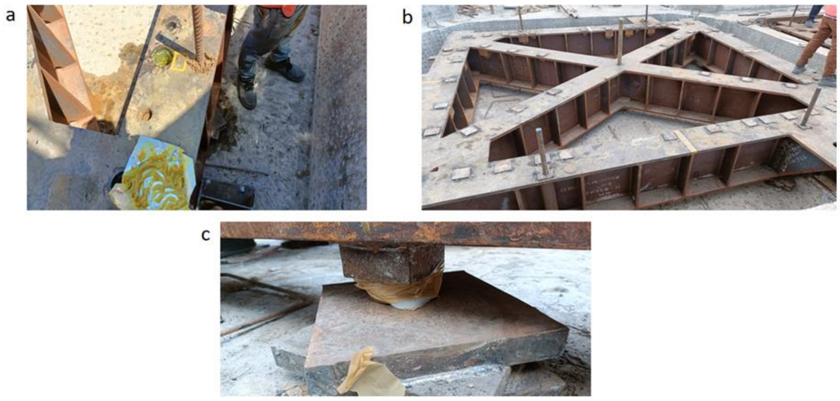


Figure 12. (a) Locking the gearbox frame; (b) Locking the motor frame.



Protecting the tapped holes and jack bolts: The first grease should be applied to the tapped holes, and they should be covered with dummy plates to protect them from concrete, on the other hand, jack bolts are to be covered with insulation tape to protect them from the concrete, as shown in Figure 13 [9-11].

Figure 13. (a) Applying grease to protect thread; (b) Protecting the threads with dummy plates; (c) Covering the jack bolt with insulation tape.



Grouting: A small hole on the four corners of the frame is to be made to release the entrapped air during the concrete. After inspection, it was released for full grouting with SCC (Self Compacting Concrete). The main benefit of using this SCC is because of its self-leveling property, as it won't require any vibrators to level the concrete.

RESULTS AND DISCUSSION

From Table 1 and Table 2, it is clear that readings taken on measured points, as shown in Figure 7 and Figure 8, using an auto level before placing the foundation frames, are in the range of 1391 mm to 1394 mm. After all the required adjustments, readings show that both the gear box foundation frame and motor foundation frame are almost at 1000 mm, *i.e.,* 1 m level.

CONCLUSION

A vibrator is typically needed when using another type of concrete because doing so might disturb the frame. Because of this, the biggest benefit in this situation is self-compacting concrete, and the jack bolts are released after grouting. The point load that was previously acting on the packing plates is now acting uniformly across the concrete surface. This aids in absorbing the mill's strong vibrations while the raw material is being ground. In the later stage, high vibration caused by a slight foundation frame center offset can be felt. The center of the shaft that rotates the grinding table in a vertical roller mill can shift slightly if the foundation frames are not positioned exactly at (0,0), which can have a significant impact on the mill's power usage and throughput. By placing the foundation frames in the middle, it is made easier to erect the vertical roller mill's other crucial components.

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