Chapter : 5 Trial Operation on a Running Motor Mounted Blower

5.1:Introduction

The directly motor mounted centrifugal blower steel base frame optimised for the blower by the experimental set up and the results being validated by the regression analysis and finite element analysis need now to be validated by application on a running equipment in the plant to finally confirm the result.

5.2 The Equipment Details

In the Ladle Repair Shop (LRS) there are 3 nos. of combustion air centrifugal blowers directly mounted on the motor shaft for the 3 sets of burners for the ladle heating areas (Figure:5.1)

Figure : 5.1 Motor Mounted Centrifugal Blowers for the Burners

The blowers supply the combustion air to the gas burners for the heating and drying of the refractory items of the hot metal ladles after relining or repair. The blowers are all centrifugal type and directly mounted on motor The motor and the blower block are mounted on a common frame which is bolted on the I-beam base frame which is bolted to the concrete base.(Figure :5.2)

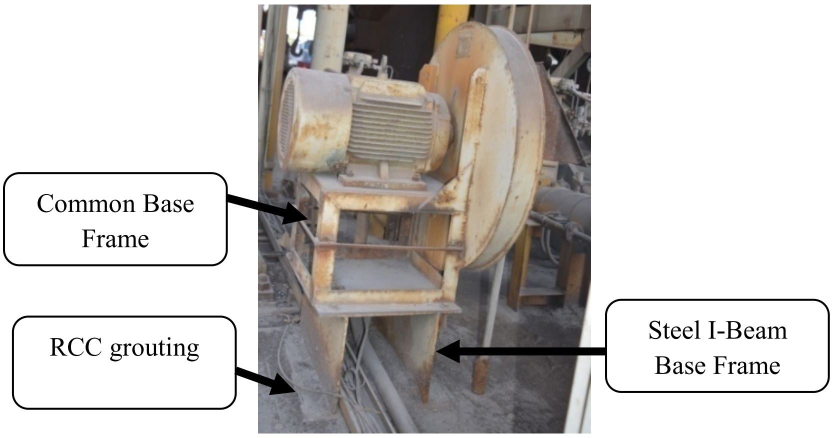

Figure: 5.2 Blower & Motor Common Frame on I- Beam Structure.

The specification of the centrifugal blower and the motor are given in Table:5.1 & Table:5.2 respectively.

Table: 5.1 Specification of the Centrifugal Blower.

Type of Blower	Motor kW	Air Volume	Total Pressure	Impeller Speed	No. of Stages
Centrifugal	11	388 M^3/H	5080 Pa	2900 rpm	Single

Table:5.2 Specification of the Centrifugal Blower Motor.

Type of Motor	Motor kW	Volts	Full Load Current	Motor RPM	Frequency	Pf	Insulation
Y2160m1-2	11	415	19.5A	2900	50Hz	0.89	IP-54

5.3 The Vibration Readings of the Blower on I Beam Base:

Vibration monitoring of the centrifugal blower were done in all three axes at motor drive end (MDE)and motor non-drive end (MNDE) bearings at the measuring points as shown in Figure:5.3

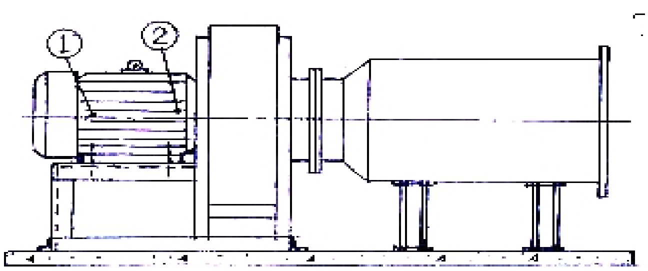

Fig: 5.3 Vibration Measuring Points at MNDE & MDE- Marked 1 & 2

The Vibration measurement of the motor non-drive end (MNDE) and at the motor drive end (MDE) bearings are shown in Tables:5.3

Table :5.3 Vibration Measurement at (MDE) & (MNDE) Bearings on I-Beam Base.

Measuring Points	Horizontal Axis(H) mm/sec	Vertical Axis(V) mm/sec	Axial Axis (A) mm/sec
MNDE	128.67	49.91	74.47
MDE	26.48	84.17	101.93

Vibration spectrum of each value of Table: 5.3 are shown from Figure 5:4-5.9

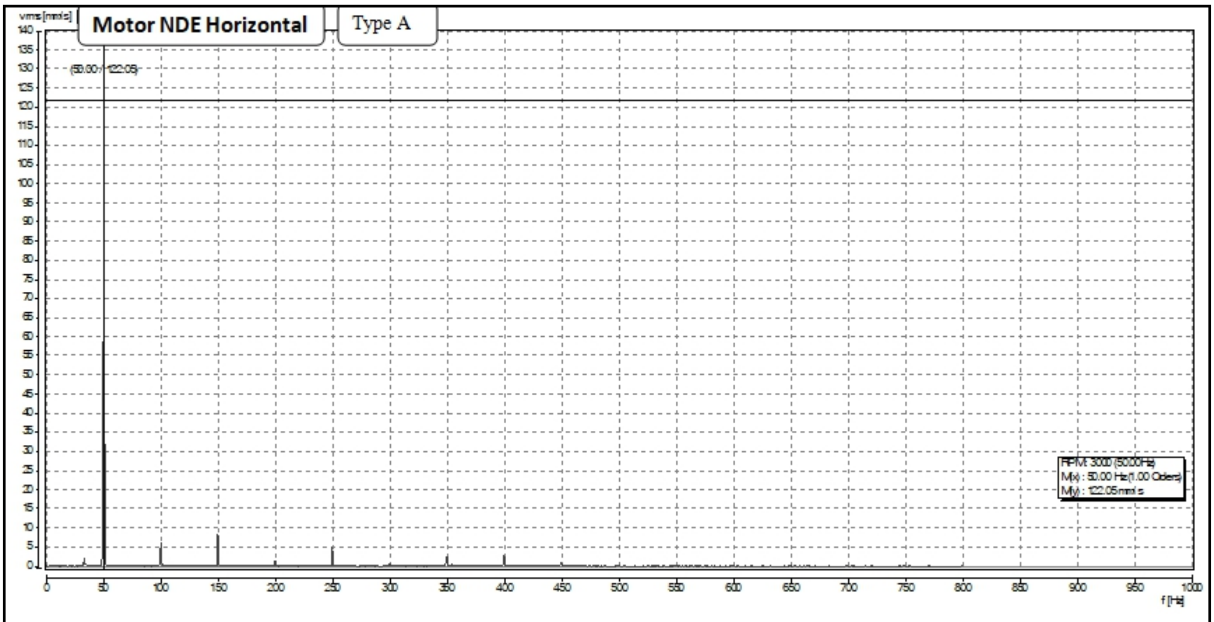

Fig:5.4 Vibration Spectrum of Motor NDE Bearing at Horizontal Axis

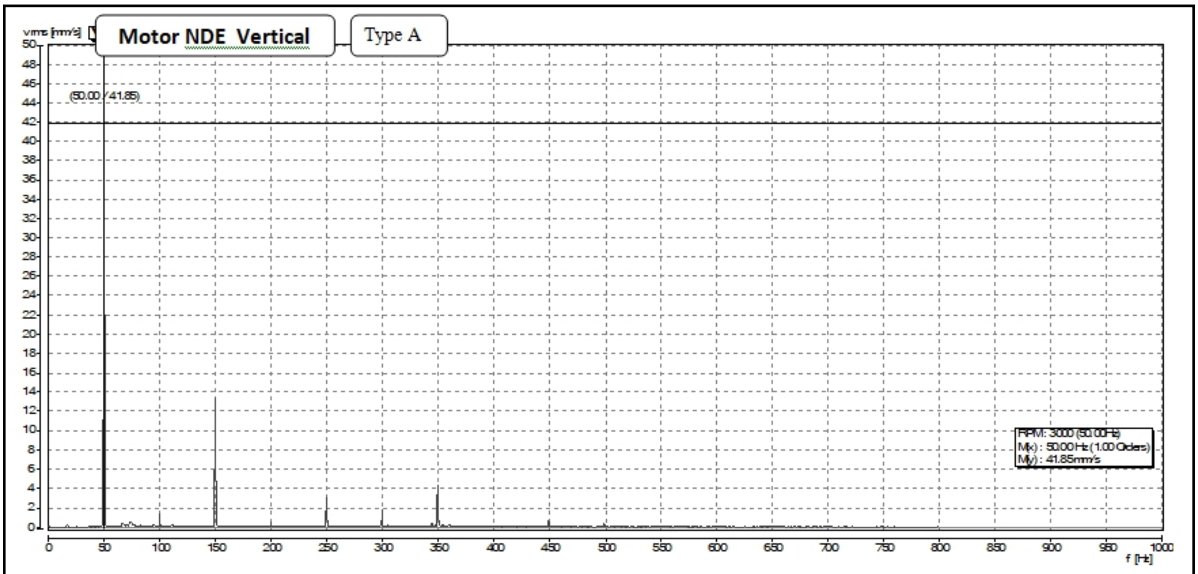

Fig:5.5 Vibration Spectrum of Motor NDE Bearing at Vertical Axis

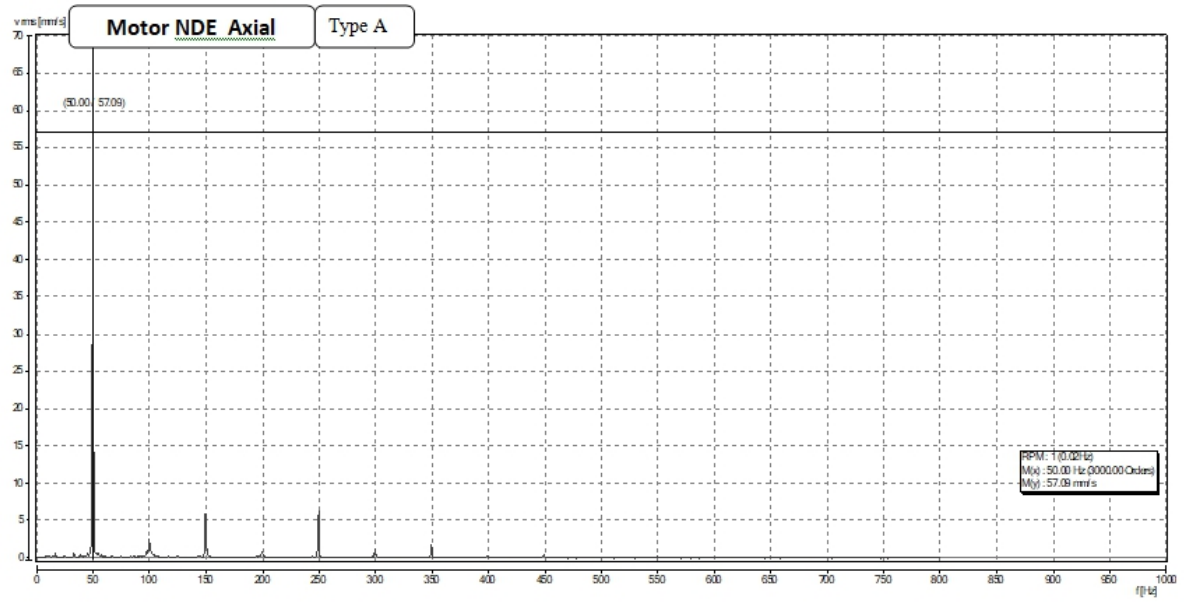

Fig:5.6 Vibration Spectrum of MNDE Bearing at Axial Axis

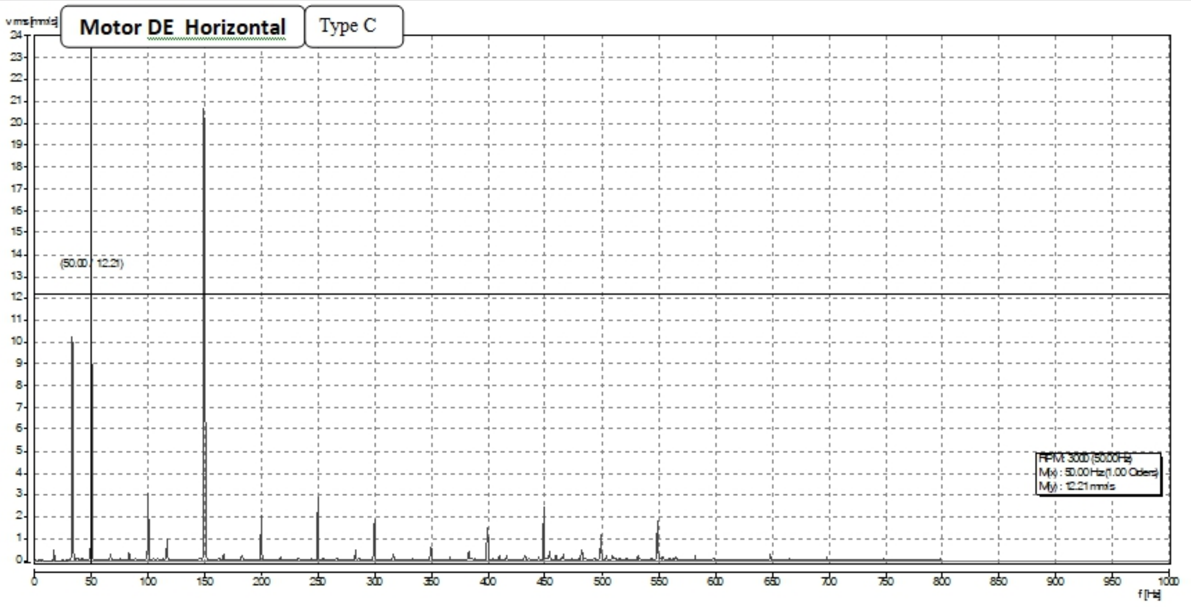

Fig:5.7 Vibration Spectrum of MDE Bearing at Horizontal Axis

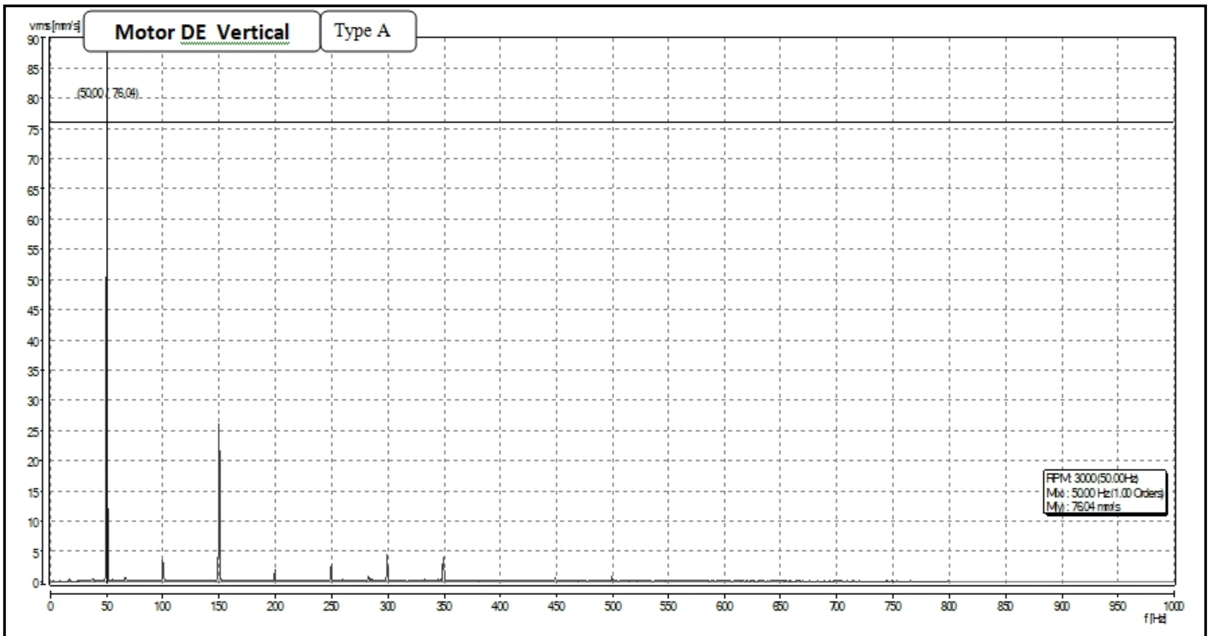

Fig:5.8 Vibration Spectrum of MDE Bearing at Vertical Axis

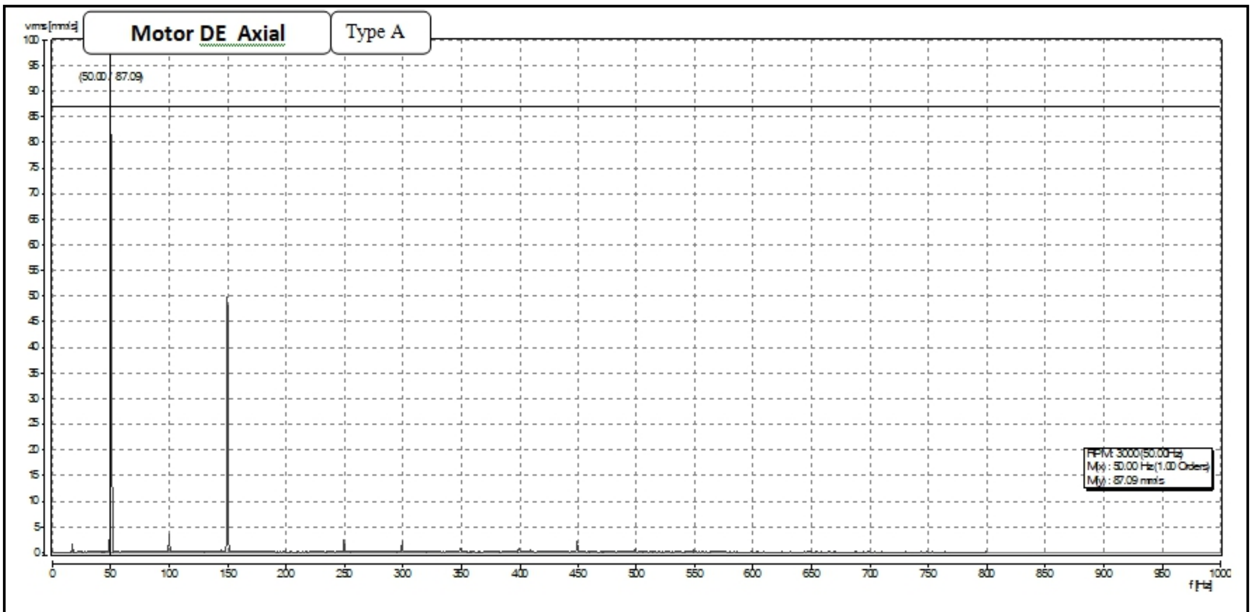

Fig:5.9 Vibration Spectrum of MDE Bearing at Axial Axis

5.4 Discussion of the Vibration Spectrum of Each Measuring Point :

In reference to Table:6.0 of the Illustrated Vibration Diagnostic Chart [Appendix B] the above spectrums are quite similar to those obtained for *Mechanical Looseness.* In the referred chart there are three types of spectrums for horizontal vibrations marked as **Type A, Type B & Type C.** According to the chart **Type A** is caused by structural looseness/weakness of machine feet ,base plate or foundation ,also by deteriorated grouting, loose hold down bolts, at the base and distortion of the frame or base.

Type B is generally caused by loose pillow block bolts ,cracks in frame structure or bearing pedestal. As there is no pillow block in this machine so this Type :B spectrum will be not much dominant .

Type C is normally generated by improper fit between component parts to dynamic forces of rotor. From the chart it is also referred that **Type A** spectrum has marked similarity to mass unbalance which is a possibility in this case . So phase analysis was done which showed that there is an approximately 180^0 phase difference between vertical measurements on machine foot base plate and machine base itself. This clearly indicated there is structural looseness and even if there is any mass unbalance it is not dominant at present. From the study of the above spectrums (Figure :5.4 to Figure:5.9) it is observed that all the spectrums are of **Type: A** except for Figure:5.7 of motor drive end bearing vibration of horizontal axis and the reason can be of rotor unbalance of which there is an indication but not dominant because of the vibration due to base weakness. From the above discussion we can now draw a conclusion for the machine defect which is generating the abnormal vibrations.

5.5 **Factors Causing Abnormal Vibration of the Motor Mounted Blower**

From the above discussion we can conclude that the reason for high vibration of the blower and the motor were due to structural weakness only as checking the tightness of the base bolts indicated there were no specific mechanical looseness. Phase analysis has also indicated the same. However there is a possibility of blower rotor unbalance but that will be dominant after rectifying the structural weakness of the centrifugal blower. As in the experimental set-up it has been verified that channel structural base is the best option for the steel base frame for a motor mounted blower it was decided to replace the I- beam of the present base with same size steel channel but keeping all other parts like the common base plate of motor and blower same.

5.6 Change Over from I Beam Base to the Channel Base:

During a suitable shut down the 300mm I beams was removed and replaced with 300 mm channel frame. The base frame drawing is enclosed (Appendix-E). Only the vertical support was changed and the base and the top plate remained unchanged (Figure:5.10)

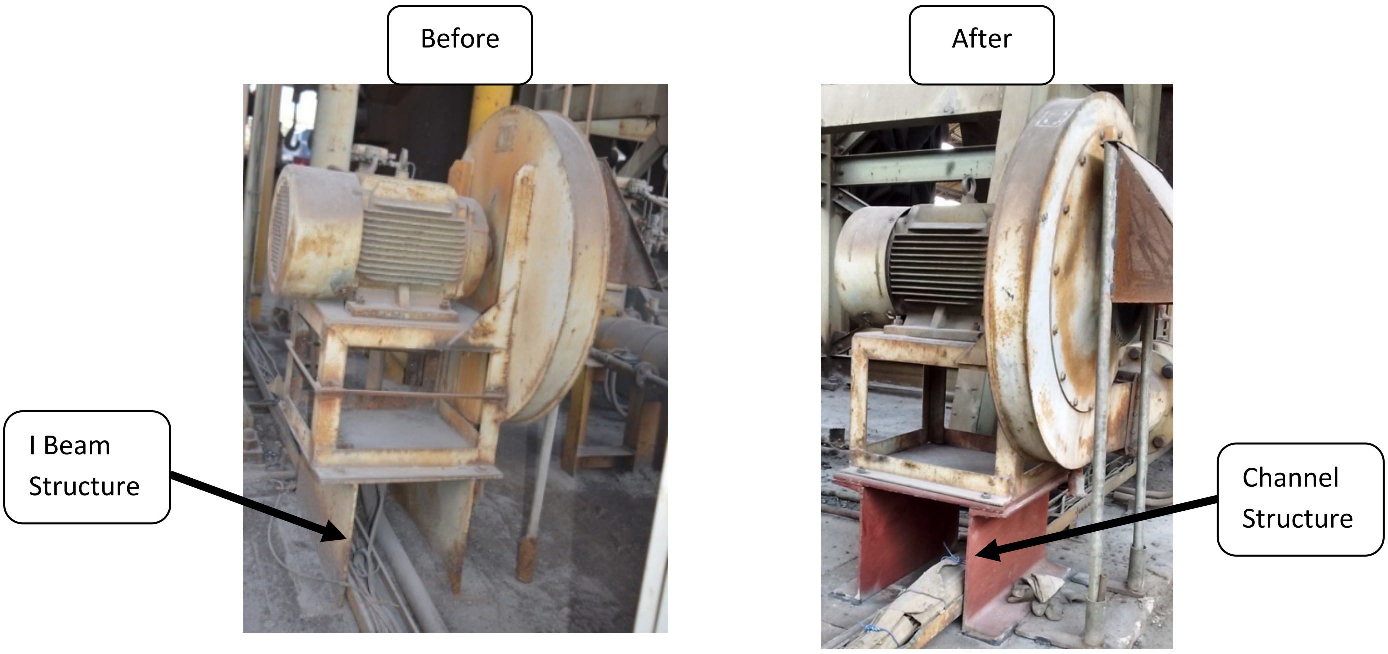

Figure:5.10 The I Beams were simply replaced by the Channel section

5.7 Vibration Measurement at Motor Drive End (MDE) & Motor Non-Drive End (MNDE)Bearings on new Channel Base.

The vibration reading taken of the motor non-drive end and drive end bearing after changing the base structure from I beam to channel is shown (Table:5.4)

Table:5.4 Vibration Measurement at MNDE & MDE Bearings after Changeover to Channel Base

Measuring Points	Horizontal Axis(H) mm/sec	Vertical Axis(V) mm/sec	Axial Axis (A) mm/sec
MNDE	15.43	3.55	3.76
MDE	8.95	9.37	3.45

It was observed that there was a drastic drop in the vibration amplitude at both the measuring points and in all the three axes as shown in the comparison chart (Table:5.5) & graphically (Figure:5.11)

Table:5.5 Comparison of the Vibration Readings After Changing from I Beam Structure to Channel Structure

Measuring Points	Mono-Bloc Blower with I Beam Base	Mono-Bloc Blower With Channel Base	% Reduction
MNDE Horizontal Axis(H) mm/sec	128.67	15.43	88
MNDE Vertical Axis(V) mm/sec	49.91	3.55	92
MNDE Axial Axis (A) mm/sec	74.47	3.76	94
MDE Horizontal Axis(H) mm/sec	26.4	8.95	66
MDE Vertical Axis(V) mm/sec	84.17	9.37	88
MDE Axial Axis (A) mm/sec	101.93	3.45	96

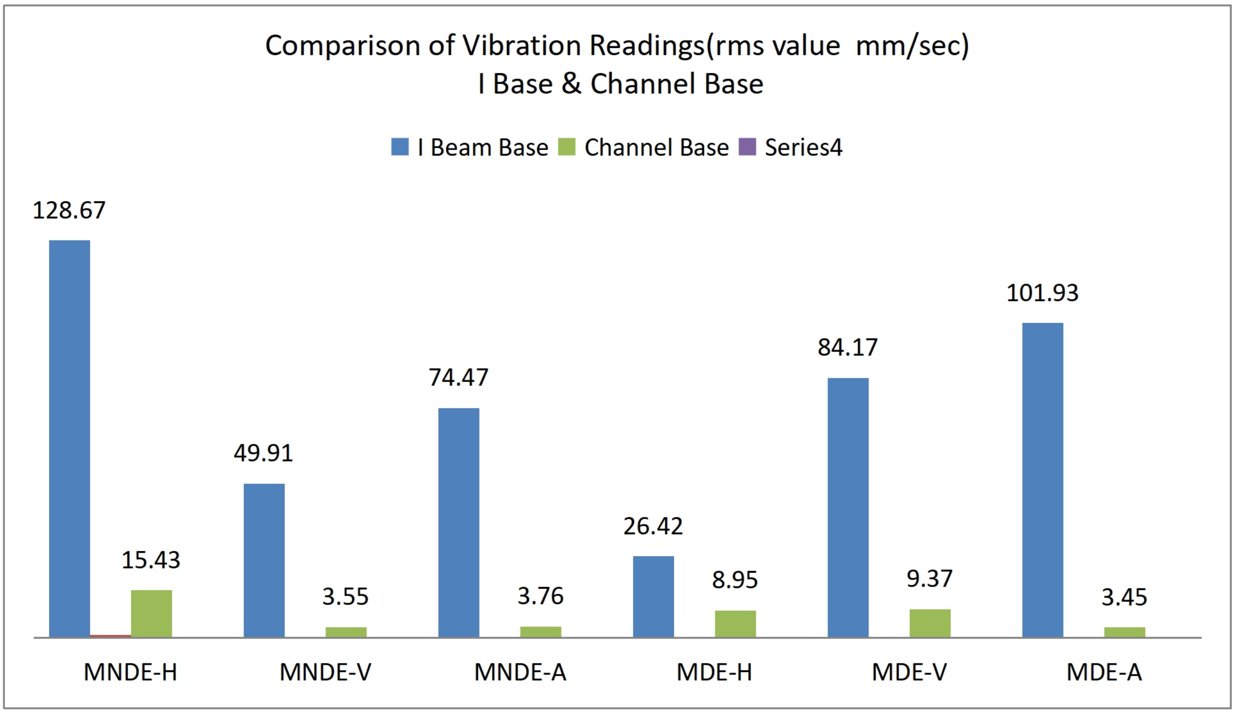

Figure 5.11 Comparison of the vibration readings of I Base & Channel Base shown graphically.

The spectrum of each vibration value of Table: 5.4 are shown from Figure 5:12-5.17

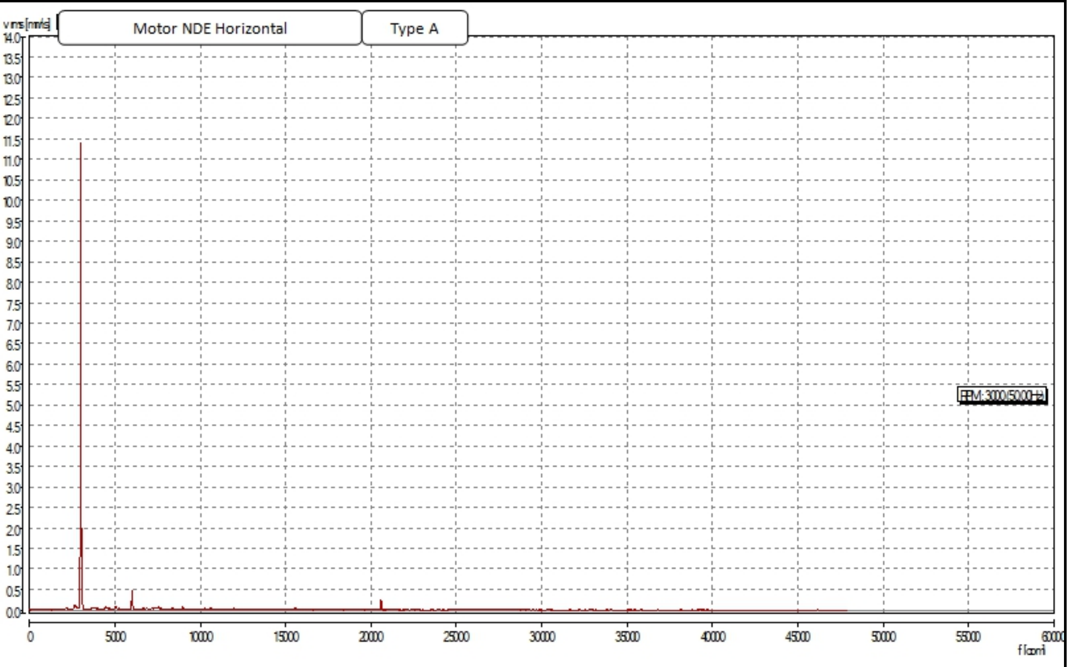

Fig:5.12 Vibration Spectrum of MNDE Bearing at Horizontal Axis

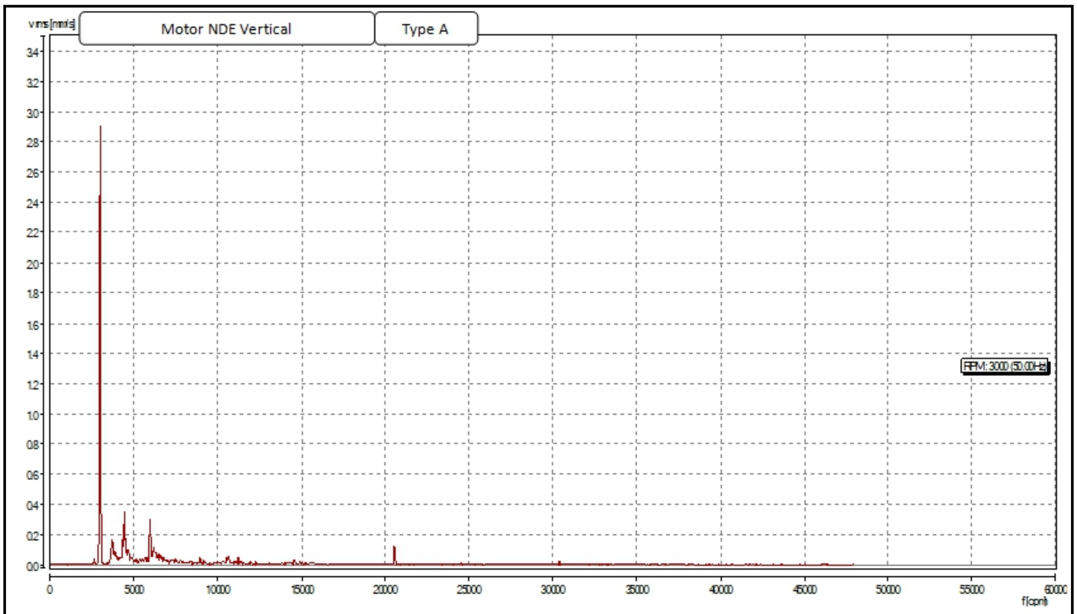

Fig:5.13 Vibration Spectrum of MNDE Bearing at Vertical Axis

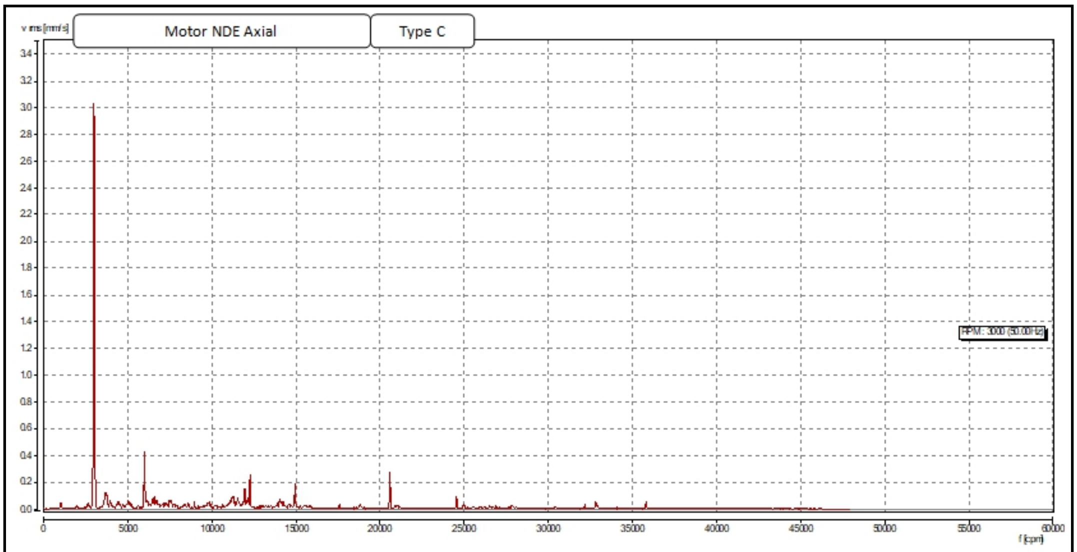

Fig:5.14 Vibration Spectrum of MNDE Bearing at Axial Axis

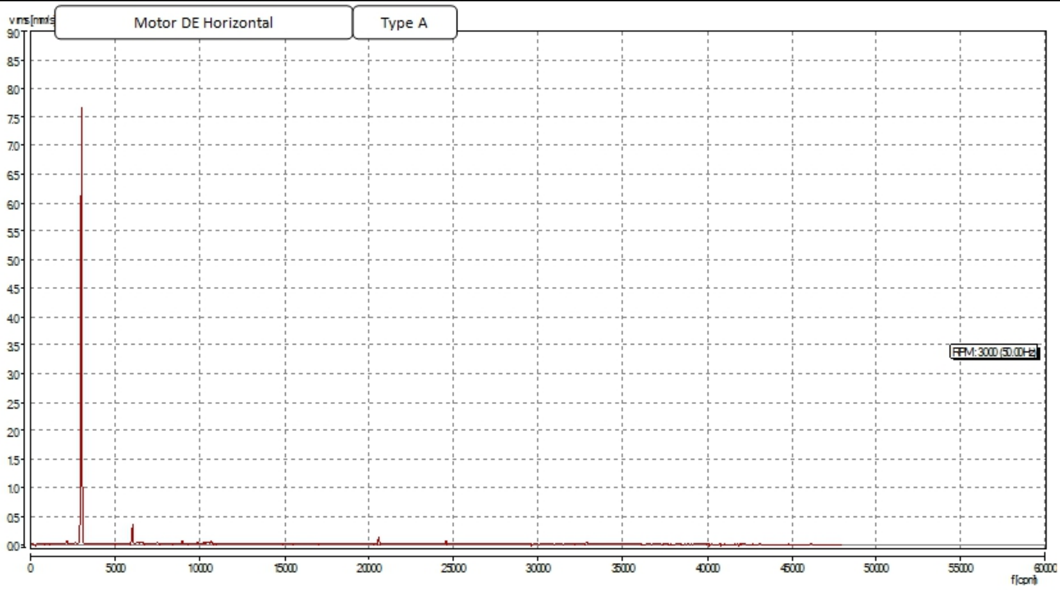

Fig:5.15 Vibration Spectrum of MDE Bearing at Horizontal Axis

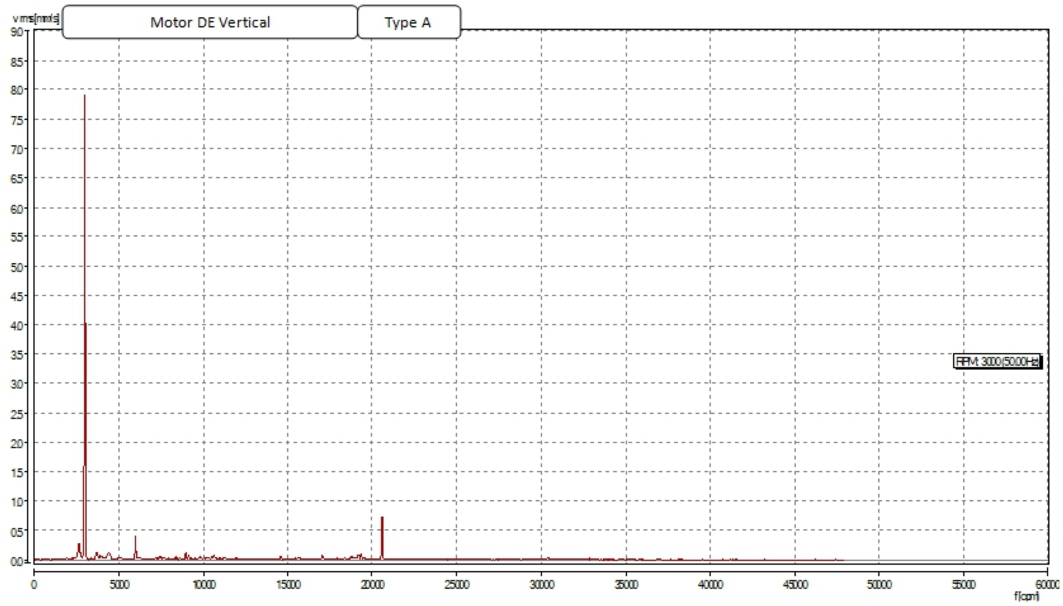

Fig:5.16 Vibration Spectrum of MDE Bearing at Vertical Axis

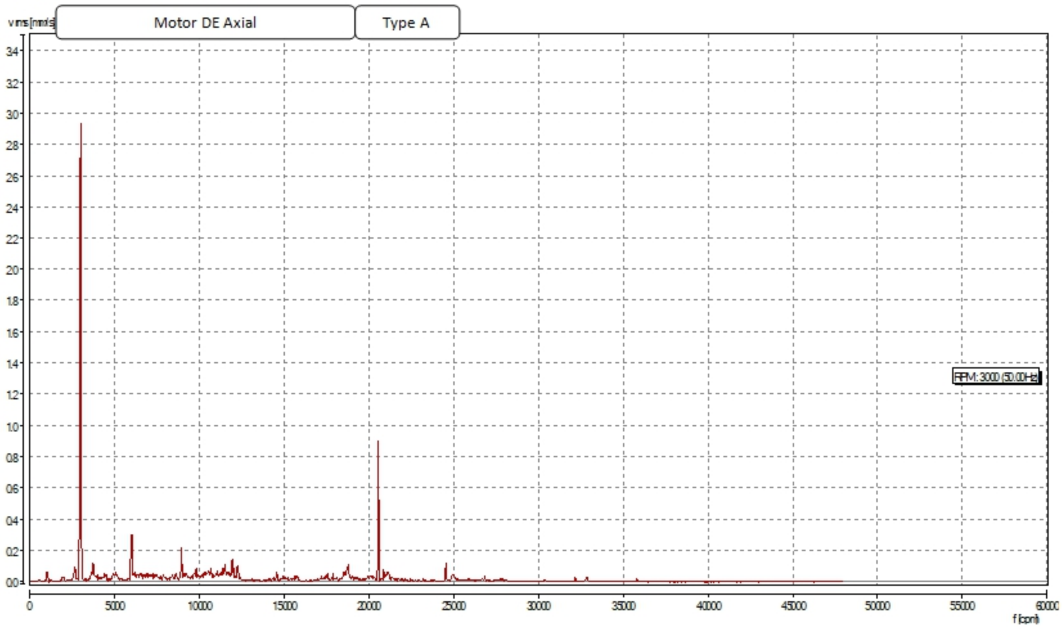

Fig:5.17 Vibration Spectrum of MDE Bearing at Axial Axis

5.8 Discussion of the Spectrums of Vibration Value of Each Measuring Point :

As discussed earlier in paragraph 5.4.0 the spectrum **Type A ,Type B & Type C** also are applicable in above spectrums generated from the vibration readings taken at the blower motor's non-drive end and drive end bearings after changing the base from I-beam to channel base.

In the supporting base frame only the 300 mm beam structural was replaced with the 300 mm channel structural and as our experimental study had confirmed that base frame with channel structural are better for centrifugal blowers mounted on motors and supported on steel base frame it has now been validated with direct application on running equipment that what has been established experimentally earlier.

After the modification of the base from I-beam to channel ,vibration level in all the axes for both the motor's drive end and non-drive end bearing had dropped significantly but there is still a residual vibration of 15.43 mm/sec (root mean square) value and 8.95 mm/sec (root mean square) value in the motor's non-drive end and drive end bearing

Based on the previous discussion the above spectrums have been classified accordingly. In the earlier discussion we had stated that **Type A** spectrum has a similarity to mass unbalance spectrum and to distinguish between mass unbalance or mechanical looseness the best option was to do the phase analysis. Phase analysis will confirm that the amplitude at 1*X pertains to mass unbalance or not and if it is found to be unbalance it can be corrected with dynamic in-situ balancing of the blower impeller.

The next step is now remains to identify for un-balance of the impeller by phase analysis.

5.9 **Phase Analysis :**

Motor drive end bearing (No:2) which is nearest to the impeller was taken as the reference point for measuring the phase difference between the bearing horizontal (Horizontal .) and the vertical (vertical)axis (Figure:5.18)

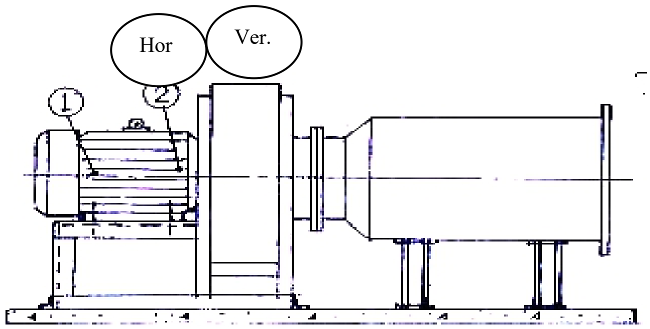

Fig: 5.18 Position in the Blower Drive –End bearing for Phase Analysis

Tony DeMateo [17] of 4X Diagnostics LLC,in his paper "Phase Analysis: Making Vibration Analysis Easier" had described various types of vibration faults that can be identified with phase analysis and to confirm imbalance he had observed" to confirm imbalance ,measure the horizontal and the vertical phase on a shaft or bearing housing. If the difference between the phase values is approximately 90^0 ,the problem is motor unbalance. If the phase difference is closer to 0 or 180^0 , the vibration is caused by a reaction force. An eccentric pulley and shaft alignment are the examples of reaction force."

In the above case we had placed one sensor on the blower's non-drive end bearing housing radial position and another sensor in the same housing in the vertical position. The phase analysis showed that there is a phase difference of $103^{\ 0}$ (Figure: 5.19) which indicates as per the observation of Toney DeMateo[17] there is an unbalance in the impeller. The printout generated by the analyser is shown in Fig:5.19

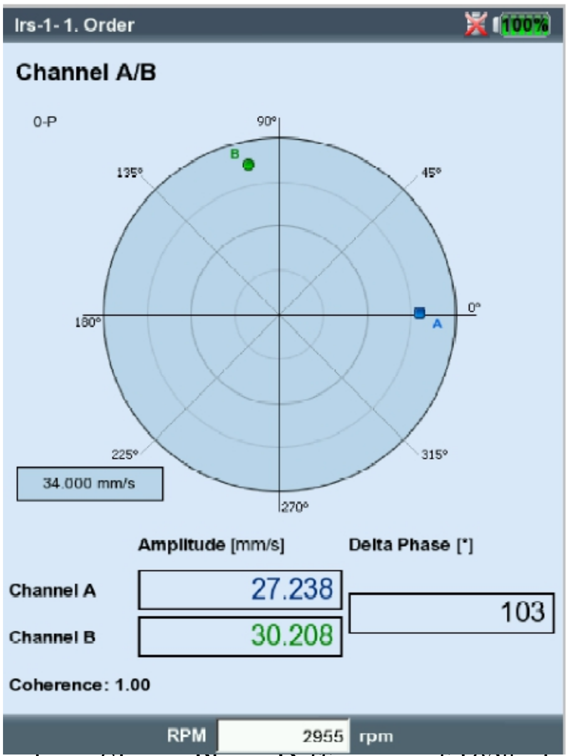

Figure:5.19 Phase Analysis Shows Phase Difference of 103° which Indicates Unbalance

Based on phase analysis report steps were taken to dynamic balance the impeller in-situ.

5.10 Dynamic Balancing of the Impeller.

The impeller was dynamically balanced in-situ . Printouts of the balancing mass and phase as indicated are shown below(Fig:5.20)

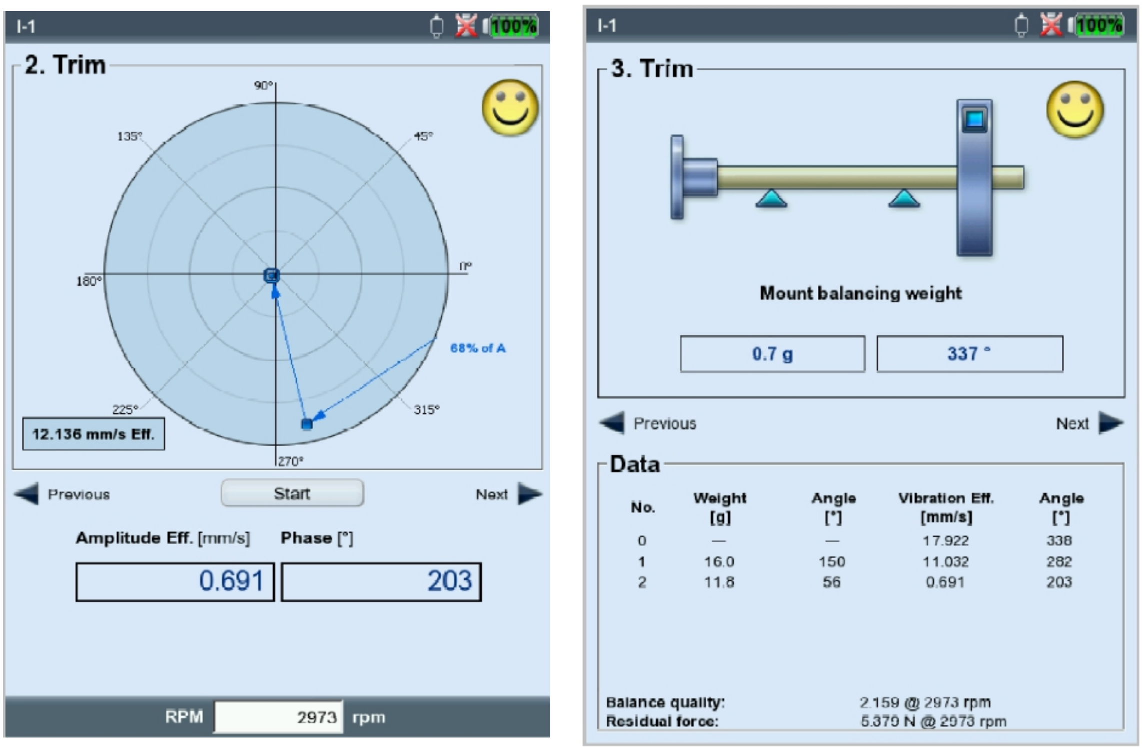

Fig: 5.20 The printouts of the balance mass and the phase angle are shown

5.11 Final Balancing of the Impeller:

As per the machine indication mass was welded on the impeller (Fig:5.21) and the machine was commissioned again at 3000 rpm.

Fig:5.21 Picture of the Impeller showing the Trial Mass & the Trim Mass welding spot.

After balancing the impeller in-situ, blower was put into operation and the final reading was taken as shown in Table: 5.6

Table:5.6 Final Vibration Readings of the Motor Mounted Centrifugal Blower After Balancing

Measuring Points	Vibration (RMS value) with I Beam Base (mm/sec)	Vibration (RMS Value After changing to Channel Base (mm/sec)	Vibration (RMS Value) on Channel Base after Balancing (mm/sec)
MNDE Horizontal Axis(H)	128.67	15.43	4.5
MNDE Vertical Axis(V)	49.91	3.55	1.0
MNDE Axial Axis (A)	74.47	3.76	2.6
MDE Horizontal Axis(H)	26.4	8.95	1.3
MDE Vertical Axis(V)	84.17	9.37	6.1
MDE Axial Axis (A)	101.93	3.45	2.9

5.12 Final Discussion & Conclusion

From the above observations and the results obtained it is evident that after replacing the base frame of the motor mounted centrifugal blower from beam to channel there was a drastic drop in the vibration measurements in all the axes and in both the non-drive end & drive end bearings but there were still some residual vibration in the blower which through phase analysis was identified as unbalance of the impeller and after rectifying the same all the vibration level were within the norms as stated in ISO 10816-3 (Appendix B)