# Vibratory Bowl Feeder: A Graphical Analysis of its Performance for Feeding Nails

**[1]Ishika Tiwari, [2]Laksha, [3]Pradeep Khanna**

*[1,2]Students, MPA Engg. Division, NSIT, New Delhi, India*

*[3]Associate Professor, MPA Engg. Division, NSIT, New Delhi, India*

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**Abstract-** *The industry has witnessed significant growth in the past two decades. The credit for this rapid growth can be attributed by large to automation. Though the concept of assembly line came into existence in early 1900s, the impetus in growth came only when different modes of automation were developed starting from fixed, programmable, flexible right up to the vision based robotic system leading to flexible assembly lines. Which so ever mode of automation/production system is being dealt with , feeding of discrete parts in desired orientation and required quantity at the point of assembly is the basic requirement. To fulfil these requirements, a number of feeding systems have been developed with vibratory bowl feeding system being the most popular, owing to its versatility and ability to feed different shaped objects. The present work is focused on investigation of feed rate performance of the vibratory bowl feeder within selected range of independently controllable input parameters like frequency of vibration, part population and part size. Experiments were conducted using one factor at a time approach and graphical analysis was done to understand the effects of these input parameters on the response of the feeder that is feed rate.*

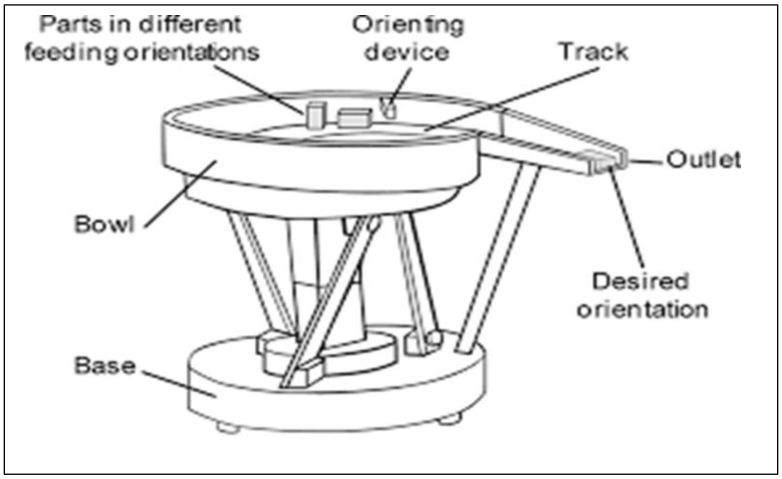
***Keywords*: Assembly line, feeder, automation, feed rate, graphical analysis**

## 1. INTRODUCTION

Feeder is a device used to feed the product or component to the assembly line in specific orientation at desired rate. To cater to the demands of automated assembly lines, a variety of feeders are in use. A few of them are listed below

- Bowl feeder
- Centrifugal feeder
- Step feeder
- Linear feeder

Vibratory bowl feeder however is the most popularly used one for its ability to handle different shapes and sizes of components. The feeder can be tailored by modifying its feeding track to accommodate the given shape and size of the component. The schematic of this feeder is given in fig. 1.




Fig, 1 Schematic of the vibratory bowl feeder[1]

These feeders are used for feeding a wide range of component in industry like pins, washers, nuts, bolts, tablets etc. Pandey et. al. and Bhahgat et. al.[2,3] carried out investigation work on this feeder for threaded fasteners and concluded that frequency of vibrations has significant positive effect on the feed rate. Jain et. al.[4] investigated the performance of bowl feeder on tablets indicating the applicability of the same in pharma industry and concluded that Taguchi approach can well be used for the optimization of feeder performance. Jindal et. al.[5,6] further concluded that the performance of vibratory bowl feeder for clip shaped components increased with increasing frequency upto a certain value and then was found to decrease. The present investigation is carried out to study the effect of varying input parameters on the output feed rate performance for a very common industrial component 'nails'. The challenge was to feed the nails in a specific orientation disregarding the interfering effect of nail heads. Graphical approach has been used to study the performance by adopting one factor at a time approach wherein one of the input parameter is varied while the others are kept constant. The process is repeated for all the input parameter and the experiments were conducted in three replications at each run to have an average value of feed rate. The technique adopted though does not take interaction effects amongst the parameters into account but still can give a preliminary and approximate performance characteristic of the feeder.

## 2.0 EXPERIMENTAL SET UP

The experimental set up for the present study is shown in fig.2. It consists of a standard vibratory bowl feeding setup with diameter of the bowl 300 mm supplied with a control unit which facilitate step less control of vibrational frequency in a range from 0Hz to 100Hz. Trial runs revealed movement of multiple nails together creating a situation of jam near the point of delivery. This problem was mitigated by narrowing down the track using a sheet metal bracket some distance before the point of delivery. A slotted channelled chute was designed and attached at the point of delivery of the feeder to ensure that every nail irrespective of the orientation it is approaching in towards the delivery point gets reoriented and is fed in head up position.

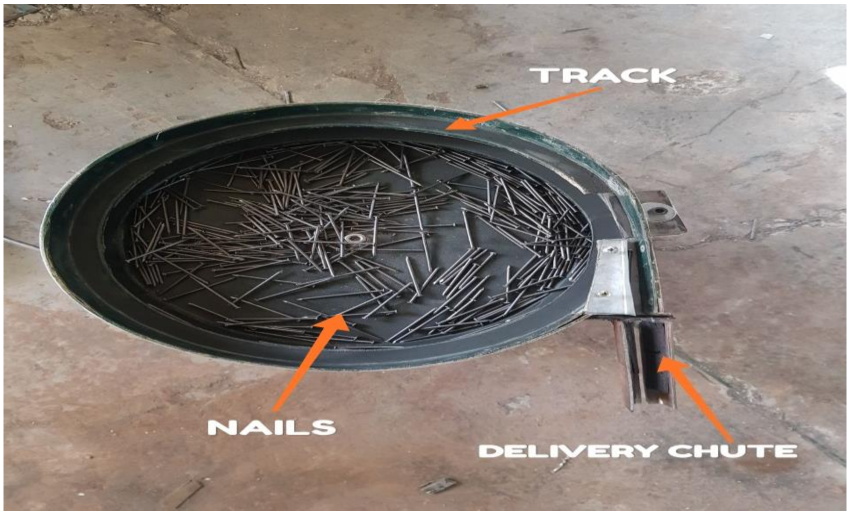



Fig. 2 The experimental set

**3.0 DETERMINING THE IMPORTANT INPUT PARAMETERS AND THEIR RANGES**

A number of trial experiments were conducted to know the various input parameters which could be frequency, part size, part population, part material, part shape and part's weight. For the present studies however first three parameters were selected as they were found to have significant effect on the feed rate. The working ranges of these parameters were then worked out by conducting a number of experiments. The higher and lower limits of these parameters are shown in table 1.

| S No. | FREQUENCY (Hz) | PART SIZE (mm) | PART POPULATION |
|---|---|---|---|
| 1 | 40 | 25 | 150 |
| 2 | 42 | 38 | 200 |
| 3 | 45 | 51 | 250 |

Table -1 The input parameters and their working ranges

**4.0 CONDUCTING THE EXPERIMENTS AND OBSERVATIONS**

The experiments were conducted in three replications at each reading and the averages were used to plot the graphs. A total number of 27 experiments were conducted as per the details shown in table 2.

**5.0 RESULTS AND DISCUSSION**

The results obtained from the above mentioned experimentation were graphically presented in the form of figures 3-5. The effect of various input parameters on the feed rate can be explained as below

| Part size (mm) | Part population | Frequency (Hz) | Observed feed rates | | | Mean feed rate (parts/min) |
|---|---|---|---|---|---|---|
| 25 | 150 | 40 | 7 | 9 | 7 | 8 |
| 25 | 150 | 42 | 64 | 56 | 60 | 60 |
| 25 | 150 | 45 | 98 | 94 | 95 | 96 |
| | | | | | | |
| 25 | 200 | 40 | 9 | 14 | 5 | 9 |
| 25 | 200 | 42 | 40 | 43 | 50 | 44 |
| 25 | 200 | 45 | 90 | 81 | 87 | 86 |
| | | | | | | |
| 25 | 250 | 40 | 30 | 31 | 36 | 32 |
| 25 | 250 | 42 | 61 | 72 | 75 | 69 |
| 25 | 250 | 45 | 73 | 82 | 85 | 80 |
| | | | | | | |
| 38 | 150 | 40 | 23 | 21 | 22 | 22 |
| 38 | 150 | 42 | 56 | 57 | 50 | 54 |
| 38 | 150 | 45 | 74 | 79 | 73 | 75 |
| | | | | | | |
| 38 | 200 | 40 | 23 | 27 | 34 | 28 |
| 38 | 200 | 42 | 63 | 57 | 53 | 58 |
| 38 | 200 | 45 | 75 | 70 | 82 | 76 |
| | | | | | | |
| 38 | 250 | 40 | 29 | 28 | 28 | 28 |
| 38 | 250 | 42 | 47 | 51 | 56 | 51 |
| 38 | 250 | 45 | 81 | 70 | 86 | 79 |
| | | | | | | |
| 51 | 150 | 40 | 11 | 10 | 6 | 9 |
| 51 | 150 | 42 | 36 | 41 | 45 | 41 |
| 51 | 150 | 45 | 62 | 66 | 65 | 64 |
| | | | | | | |
| 51 | 200 | 40 | 17 | 19 | 11 | 16 |
| 51 | 200 | 42 | 38 | 36 | 35 | 36 |
| 51 | 200 | 45 | 55 | 63 | 66 | 61 |
| | | | | | | |
| 51 | 250 | 40 | 8 | 9 | 7 | 8 |
| 51 | 250 | 42 | 35 | 25 | 31 | 30 |
| 51 | 250 | 45 | 48 | 49 | 41 | 46 |
| | | | | | | |

**Table 2.** Observation

### 5.1 Effect of frequency on feed rate

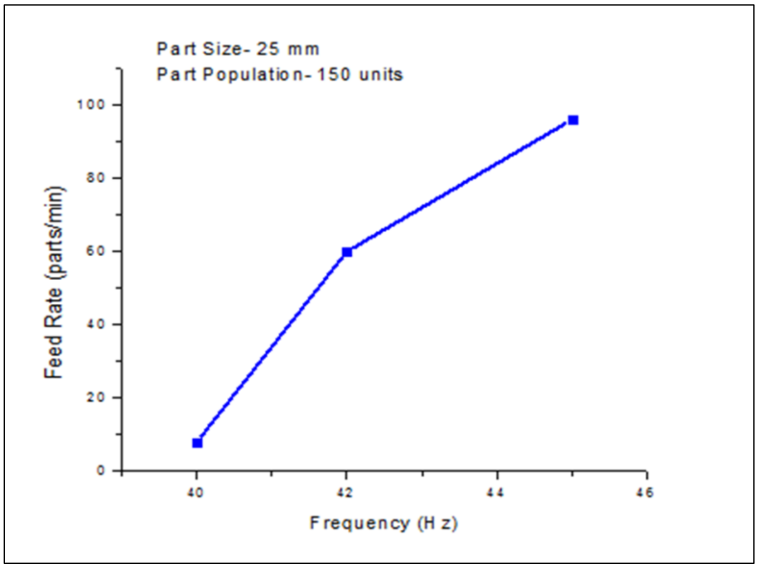



Fig. 3 Effect of frequency on feed rate

The effect of frequency on feed rate is shown in fig.3. It is evident from the figure that frequency has a strong positive effect on the feed rate. The probable reason could be that with the increase in frequency the magnitude of the vibration of the component is increased which caused their faster movement up the spiral track and to the final delivery chute.

### 5.2 Effect of part size on feed rate

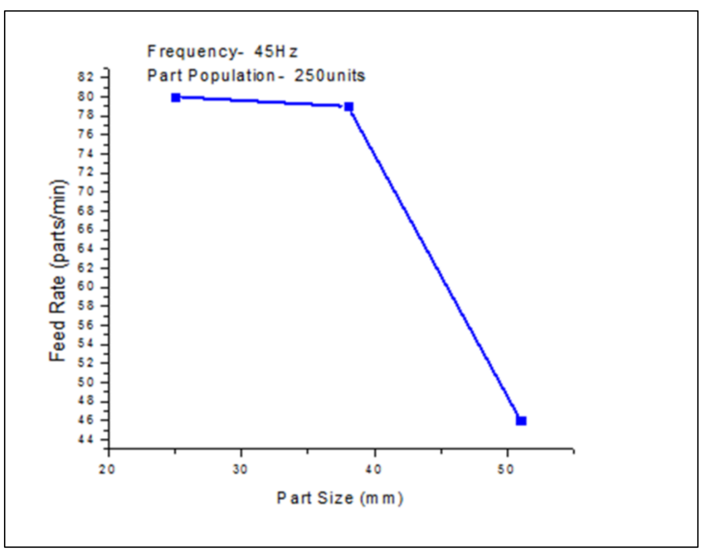



Fig. 4 Effect of part size on feed rate

Effect of part size on feed rate is shown in figure 4. It is seen that there is a slight fall in feed rate with increase in part size initially whereas in further increase in size the fall becomes quite steep. The overall observation is that part size has negative effect on feed rate the reason for this could be attributed to the fact that when part length increased, the interaction between them also increased which becomes more prominent at larger part length. This interaction some how hinder the smooth flow of the parts up the track thereby reducing the feed rate.

### 5.3 Effect of part population on feed rate

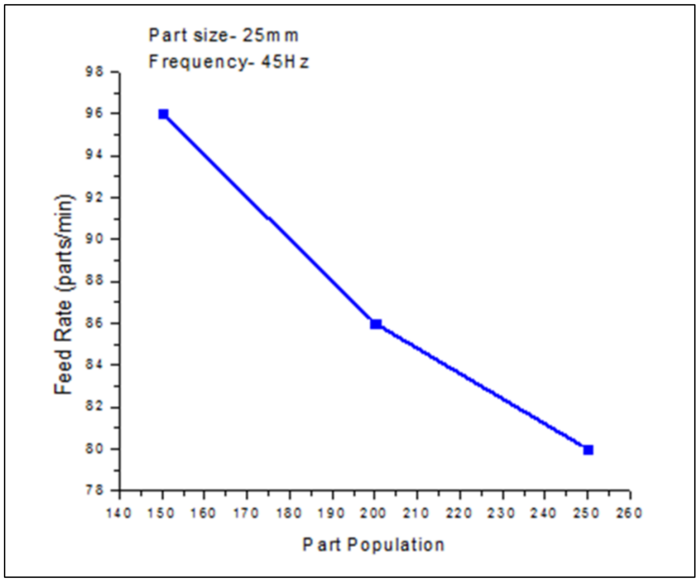



Fig. 5 Effect of part population on feed rate

Effect of part population is shown in figure 5.It is seen that there is a considerable fall in the feed rate with increasing part population. As the population was increased it was observed that at the narrowed junction, the parts were in a state of disorder and were hindering each other from following the main path thereby reducing the overall feed rate.

### 6.0 CONCLUSIONS

1. The frequency of vibration has positive effect on the performance of vibratory bowl feeder.
2. Part size and part population were found to have negative effect on feed rate performance of the feeder with part population having more pronouncing effect.
3. Maximum feed rate of 96 parts/min was obtained at a frequency of 45Hz, part population 150 and part size 25mm.
4. Minimum feed rate of 8 parts/min was obtained at a frequency of 40Hz, part population 250 and part size 51mm.

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