Dynamic analysis of block type machine foundation as per IS: 2974 (Part-I) – D.D.Barkan method by application software

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ABSTRACT

Today most of the analysis and design processes are done on the computers day-by-day. The ongoing process of invention makes it more and easier. In this work, the analytical solutions are programmed for dynamic study of block foundation. The results can be obtained in detailed text file, so that the user can easily understand.

This application package is developed by me, using latest standards of Visual C++. The reliability of this package can be checked with manual work. In this package, Visual C++ is used because; it is the most powerful tool among all other programming tools.

Keywords: *Visual C++, Block type machine foundation, D.D.Barkan method.*

1. INTRODUCTION

Some 70 to 80 years ago, no great practical importance was attached to the effects on structures of vibrations produced by seismic waves from industrial sources. These seismic waves from various industrial sources may have a harmful effect on structures, technological processes and people. Therefore the study of the action of seismic waves from industrial sources is of great practical importance.

The industrial sources mainly include the machines of low-frequency engines, such as horizontal piston compressor, diesel and reciprocating steam engines. The speeds of these engines rarely exceed 500 rpm. Engines of this type are more dangerous for structures than any other machines.

Today, varieties of professional software are available to deal with any complex problems. However, it is very much difficult to obtain the analytical solutions of foundations, which are subjected to vibrations using available software. Hence, in this context, an attempt is made to obtain good and reliable analytical solutions of block-type machine foundations using this software.

EXAMPLE: Using "D.D.Barkan method"

Find the displacement of machine foundation block as per following data:

Machine Data:

    [1]   Operating speed of engine = 180 rpm

    [2]   Power of engine = 5 HP

    [3]   Weight of the machine = 36000 kg

    [4]   Permissible amplitude = 0.2 mm

    [5]   Bedplate dimension: 1m x 0.5m

Soil Data:

    [1]   Nature of the soil: Medium Sand

    [2]   Bearing capacity of the soil = 196.2 kN/m^2

[3]   Coefficient of elastic uniform compression = 49050 kN/m^3

[4]   Coefficient of elastic uniform shear = 24525 kN/m^3

[5]   Coefficient of elastic non-uniform compression = 91723.5 kN/m^3

[6]   Coefficient of elastic non-uniform shear = 36787.5 kN/m^3

[7]   Depth of foundation = 2.2m

Force Data:

[1]   Net Vertical and Horizontal exciting force = 150 kN

[2]   Fatigue factor = 3

[3]   Construction load = 7 kN/m^2

[4]   Horizontal force acting at a height above G.L = 0.8m

Material Data:

[1]   Grade of concrete: M 20 & Density of concrete = 24 kN/m^3

2. SOLUTION

A. INPUT DATA

Let, the foundation is to be divided into '5' elements, the first element are the bottom most part having 0.2 m thickness. The other dimensions of the elements are as given below:
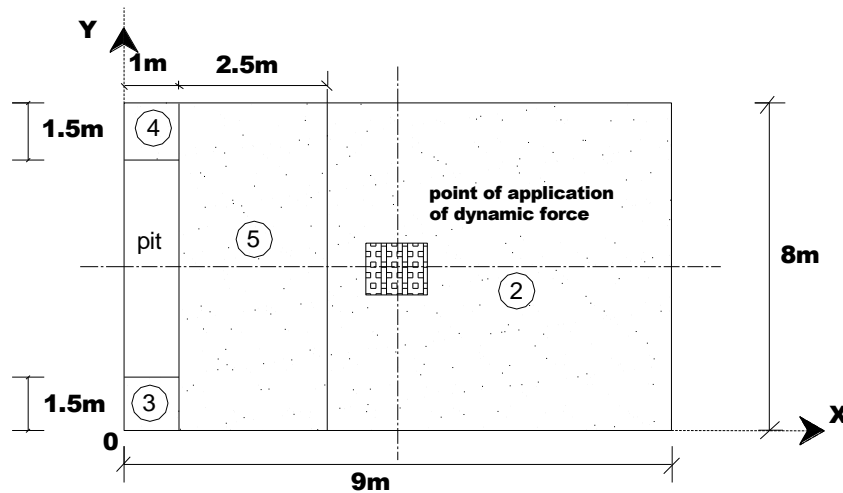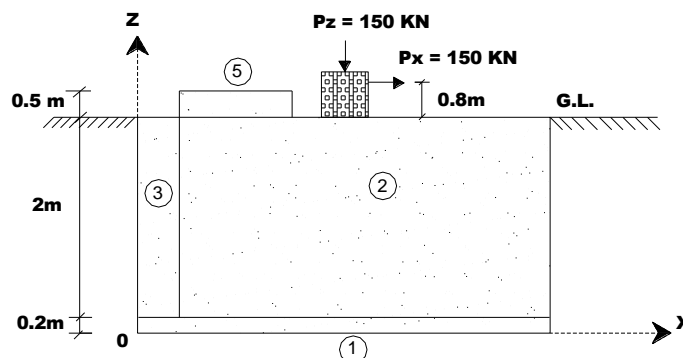

Fig. 1 Plan

Fig. 2 Elevation

Table 1. Dimensions of each element

Element No.	Dimensions (m)			Co-ordinates of c.g. (m)		
	L	B	D	Cx	Cy	Cz
1	9.0	8.0	0.2	4.5	4.0	0.1
2	8.0	8.0	2.0	5.0	4.0	1.2
3	1.0	1.5	2.0	0.5	0.75	1.2
4	1.0	1.5	2.0	0.5	7.25	1.2
5	2.5	8.0	0.5	2.25	4.0	2.45

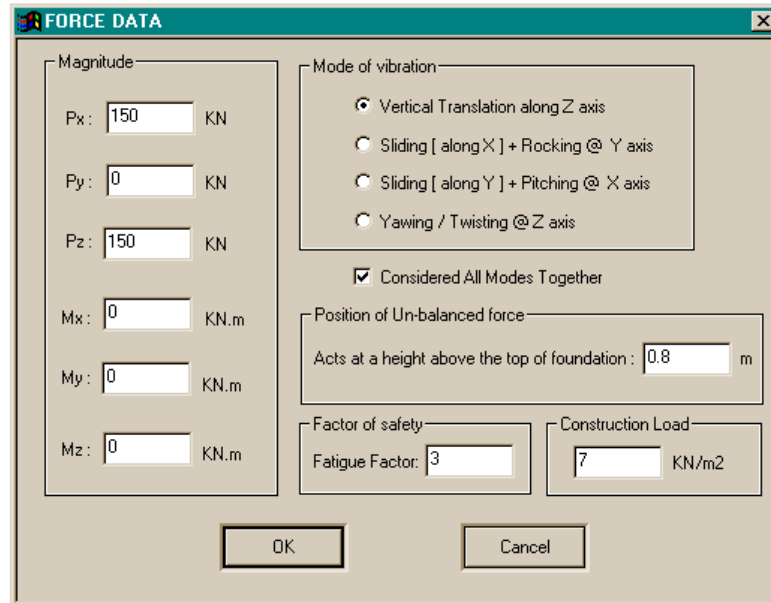**Fig 3 Machine data**

Fig 4 Soil data

Fig 5 Force data

After inserting all data click on "O.K" in the main dialog box.

B. ANALYSIS RESULT

To show the geometry of the system, click on "Geometry" menu and then click on "Show", you will see the geometry as shown in FIG 6.
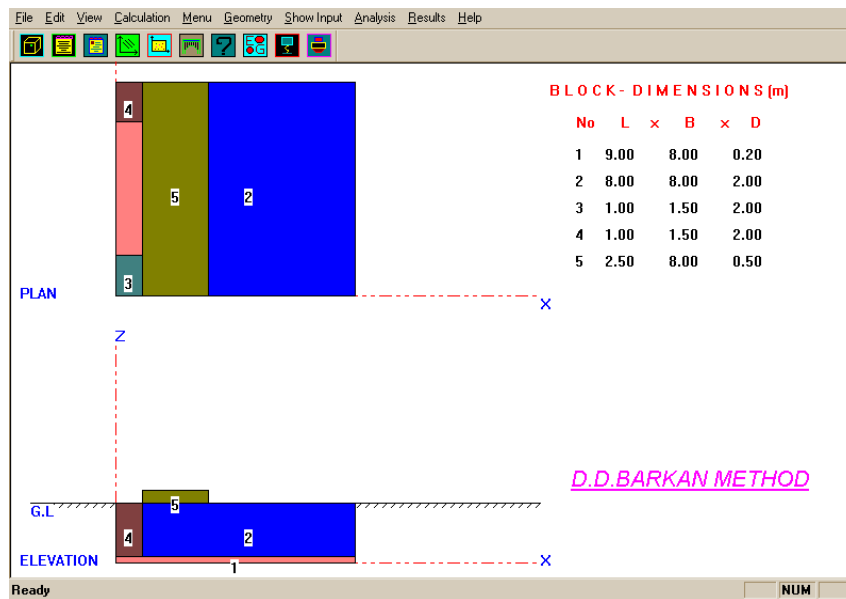

Fig 6 Geometry of example

Click on "My Toolbar", One can see the c.g. of the whole system as shown in FIG 7.
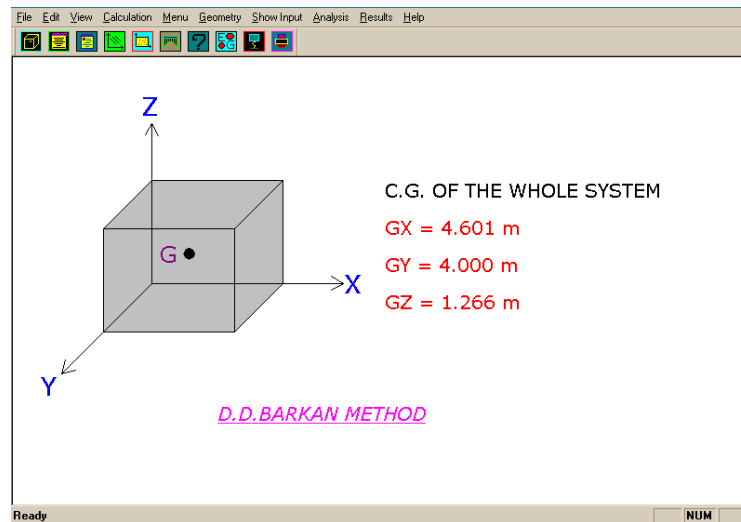
Fig 7 Center of gravity (C.G.) of the system

Above Fig 7 shows the center of gravity of system at which the total force is assumed to act. In this case, all the values are positive; it means that it is in the same direction as the direction of reference axis chosen. It must be noted here that, the origin of these reference axis is taken at the bottom most point in the plan of this geometry. In this package, one should enter all foundation data positively. This is because in this package, the geometry of foundation is taken as in first quadrant of reference axis chosen. The detailed calculation of this c.g. of system can be seen by clicking on "Result" menu, and then select "D.D.Barkan method", and click on "Output". One can see the output file as shown in Fig 8:
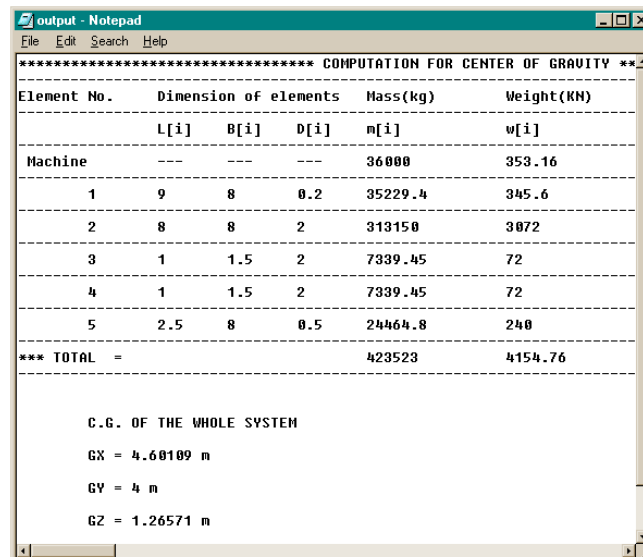

Fig 8 Calculation of C.G.

To see the bottom plan of the given geometry, Click on bitmap no.5 in "My Toolbar", One can see the view as shown below:
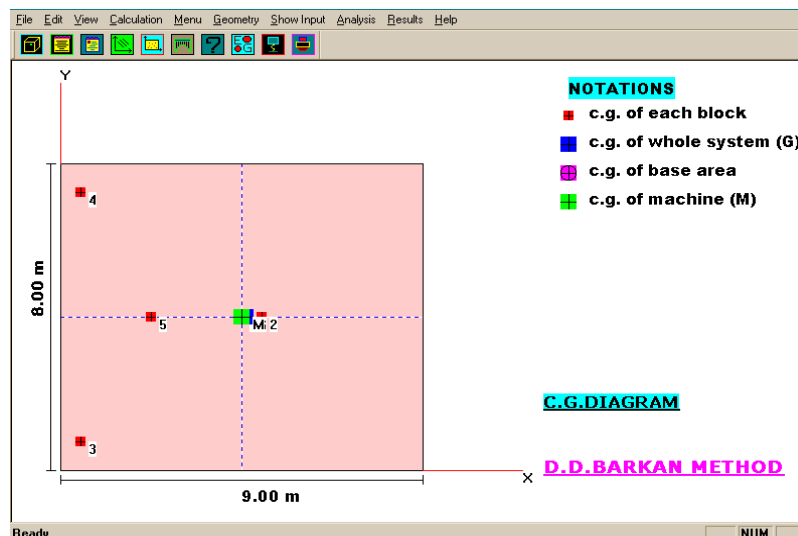

Fig 9 C.G. DIAGRAM

Above Fig 9 shows the C.G.diagram of the system. The base dimensions will appear in respective direction of axis. From this view, we can see the c.g. of each block, the C.G. of machine and the C.G. of base area. You can obtain the summary report by clicking on "My Toolbar", as shown in Fig 10.
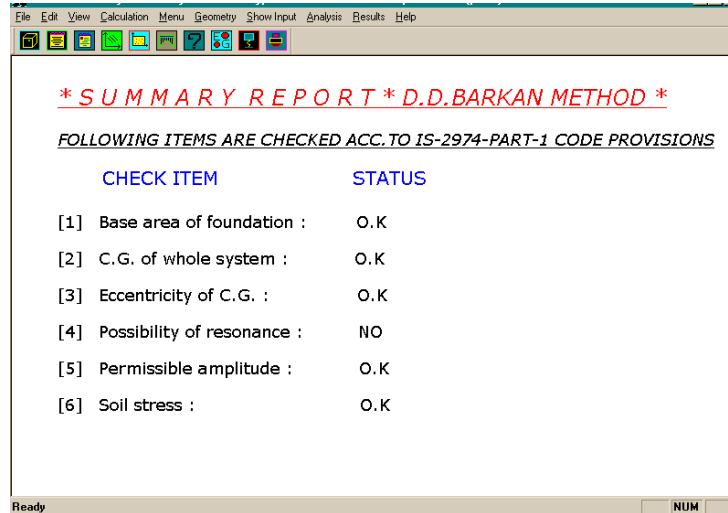

Fig 10 Summary report

This report gives the information of each possible clauses of IS: 2974 (Part1) and check the same for given data. For example, third item "Eccentricity of C.G." is O.K. It means that as per clause of IS: 2974 (Part1), the eccentricity of C.G. of whole system and C.G. of base area should not exceed 5% in each direction. In other words, the C.G. of whole system and C.G. of base area should lie in same vertical line as far as possible. This package also checks the possibility of resonance of system. Analysis results and summary can be obtained as shown in Table 2 and Table 3:

Table 2. Analysis results

Mode of vibration	fn (cps)	Amplitude	Frequency Ratio
Vertical (z)	14.5334	0.044364	0.206421
Sliding (x) & M @ y	21.7588	0.117844	0.137875
	9.88099	0.117844	0.303613
Sliding (y) & M @ x	20.4125	0	0.146969
	9.76473	0	0.307228
Twisting @ z	13.4209	0	4.47362

Table 3. Summary of result

Mode of vibration	Natural freq. (rad/sec)	Amplitude
Vertical (Along-Z)	91.3161	0.044364 mm
Sliding (Along-X)	64.5702	0.107774 mm
Sliding (Along-Y)	64.5702	0 mm
Rocking (About-X)	107.459	0 rad
Rocking (About-Y)	116.966	1.07781e-005 rad
Twisting (About-Z)	84.326	0 rad

3. CONCLUSION

Following are the advantages of software:

- This package is user friendly for dynamic analysis of block foundation problems.
- The package can be used as a tool to prepare academic problems related to machine foundation.
- This software is a powerful tool, which can display colorful geometry and c.g. diagram.
- This is powerful software, which covers almost all types of input data and gives all types of inertia and dynamic forces.
- Special help content dialog is also inserted to guide the user while using this package.

4. REFERENCE

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