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COMPUTATIONAL ASSESSEMENTS REGARDING MODAL ANALYSIS OF AN ELEVATOR BUCKET

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ABSTRACT

This paper deals with an equipment of elevator type, which is intended to feed an installation for preparing mortar and concrete, with the role of a continuous feeding of the mixer with aggregates. For this elevator, based on known data about the size and the capacity of the bucket, in the paper the 3D modeling of the bucket will be achieved and will be determined the vibration eigenmodes for this one, using a specialized software of finite element analysis, namely ALGOR.

KEYWORDS: elevator bucket, 3D modeling, specialized software of finite element analysis

1. INTRODUCTION

The continuous handling equipments are used to move loads through flexible tensile elements, such as: cable, chain or gang [1], [2], [8].

The conveyor with belt is used in mining to transport the materials and in the forestry industry to transport firewood, wood for pulp or materials used in constructions.

The conveyor with belt is an item of continuous fixed equipment which consists of a conveyor belt, the supports for supporting, the rollers for driving the rubber belt and a chassis for the belt with scrapers.

The conveyor with rubber belt is used for inclination up to 18^0 for the transport of less abrasive materials in small pieces as size.

2. THEORETICAL APPROACHES

The elevators are technological equipments which are used for the transport of loads in the vertical direction [8].

A classification of the elevators divides this group of equipments into two versions:

- chain and bucket elevators;
- tape and bucket elevators.

Tape and bucket elevators are distinguished by a low weight and lower costs, allowing operation at higher speeds than the embodiment with the chain and achieve a higher productivity [3], [7].

In conclusion, the conveyor with rubber belt presents the following advantages:

- it can transport large volumes of material, in continuous or intermittent flow, as appropriate;
- the transport process is silent and does not pollute the environment;
- the energy efficiency is high;
- the operation and the maintenance are facile and can be made by persons who have average professional qualifications;
- it can be easily adaptable to different lengths of transportation.

The elevator from this paper is intended to feed an installation for preparing mortar and concrete, with the role of a continuous feeding of the mixer with aggregates. Thus, the elevator reduces the energy consumption and increases the feed flow with aggregates.

The elevator buckets have different shapes, depending on the properties of the transported material. Thus, they can be deep or short, rounded or sharp [2].

Fig. 1 The bucket models

The deep rounded buckets are used to transport materials with small granulation and which are leaking slightly, ie the granules glide effortlessly from each other (the case of cereals).

The short rounded buckets are used to transport the materials which adhere to the sides of the bucket, such as wet sand, wet sawdust, cement.

The sharp buckets are used to transport materials with high and middle granulation, like the crushed stone or minerals of any kind.

The buckets are fixed to the traction equipment depending on its type (flexible belt, chain with articulated link) and depending on the carried weight [2], [8].

There are known several variants of gripping the buckets on the band.

The buckets are created according to the normative regulations from the European Union and the used materials are steel, stainless steel or rubber.

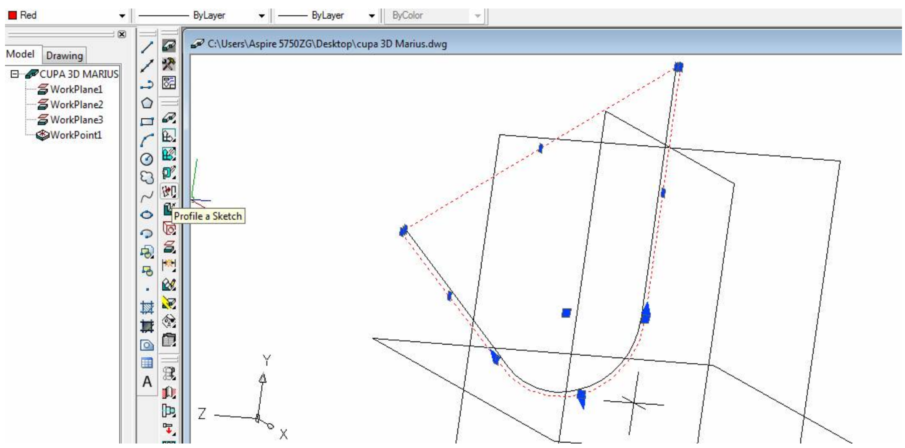
In the case of steel buckets, they are performed by welding, using plates with a thickness of 1.5-3 mm.

3. CASE STUDY

In this paper it will be considered the case of a steel bucket with a 3 mm thick sheet, mounted on an elevator band. For this bucket the 3D design will be made in Mechanical Desktop.

The Mechanical Desktop application enables the possibility of the verification of form, conformity and functionality of a new technical concept, greatly reducing the need to verify a solution through physical prototypes. The software solution of Mechanical Desktop 8 facilitates the use of 3D digital prototype to design, visualize and simulate (by importing in other specialized applications) in a digital mode the functionality of future products and, as such, the communication of the development results is more efficient, the errors are reduced and the delivery of a product with a higher degree of innovation is faster [5], [6], [9].

As a first step the landmark sketch was created, using commands such as line, circle, trim-extend.



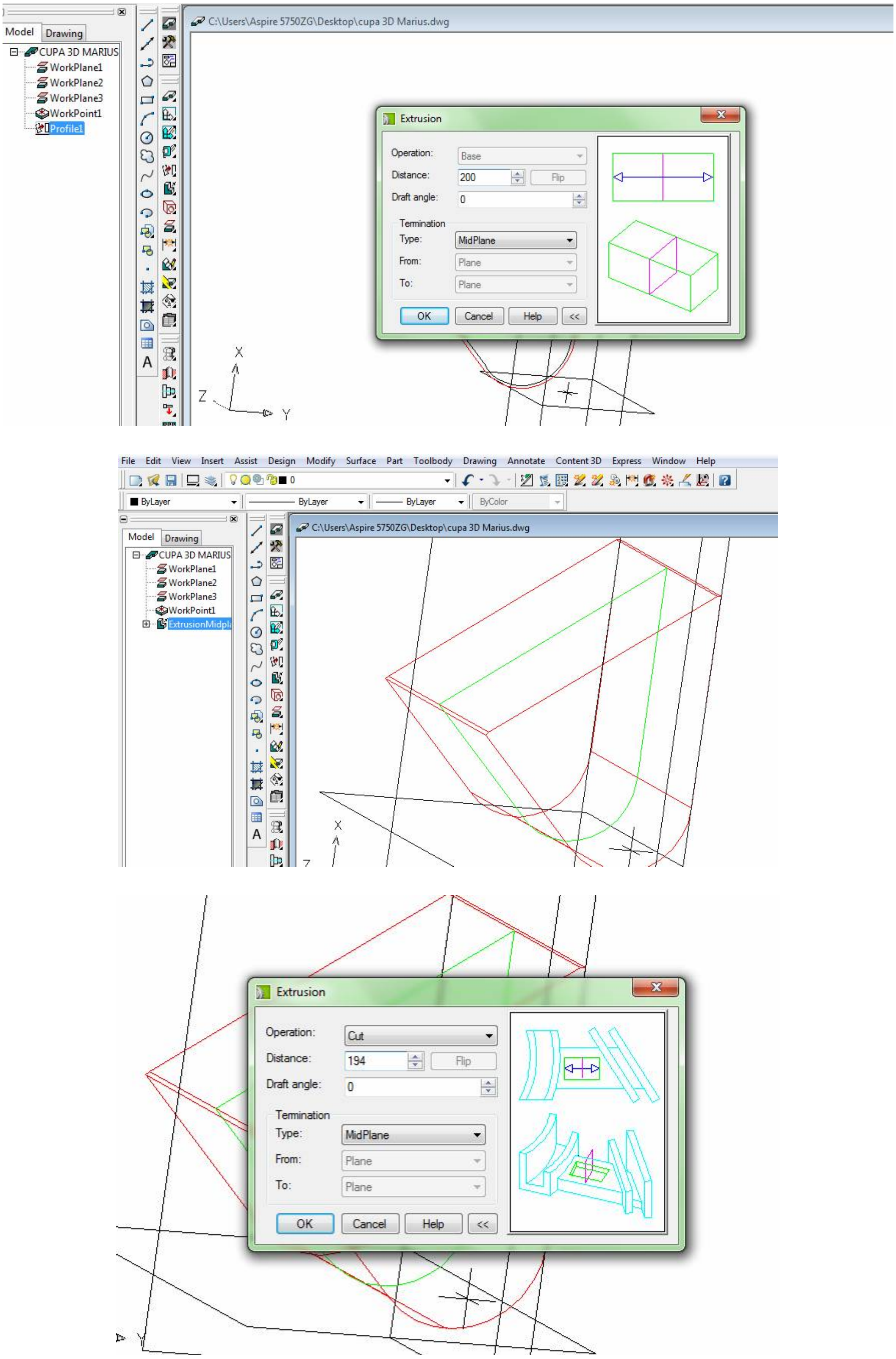


Fig. 2 The bucket sketches

After creating the sketch, using commands such as extrude, profile a sketch, the 3D model of the part was created (fig. 3).

In figure 4 the bucket is presented in the final constructive version, modeled with Mechanical Desktop 8.

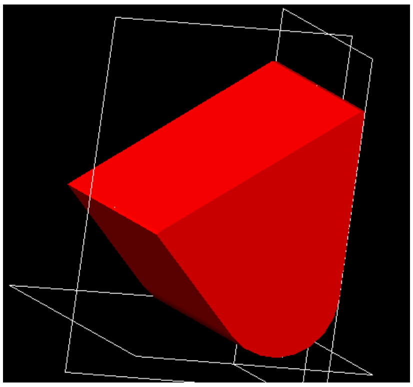
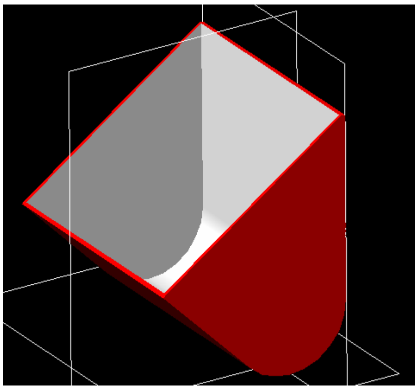


Fig. 3 The gross bucket



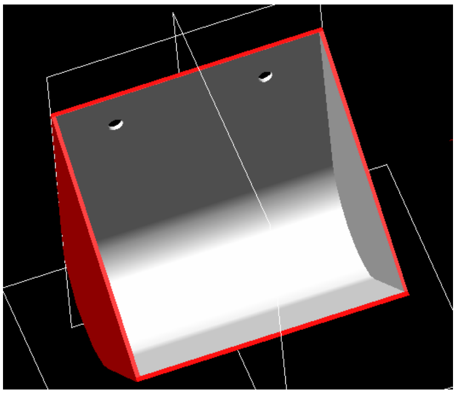


Fig. 4 The final version of the bucket

The bucket depicted above is afterwards subjected to the finite element analysis.

The finite element method attempts to find an approximate solution to a problem, admitting that the area is divided into subdomains or finite elements with simple geometric shapes. Thus, the finite element method is a very convenient way to obtain approximate solutions for almost any engineering problem. The method is a convenient and necessary tool in the design calculations and research [4].

In this paper was considered and analyzed the case of analysis in frequency, from which results the behavior of the working equipment of an elevator bucket type, in the first 10 vibration eigenmodes.

To begin, the bucket of the elevator was imported from Mechanical Desktop 8 and analyzed in ALGOR, a dedicated software for finite element analysis. The analysis aims to highlight the behavior of the elevator bucket in terms of displacements of the structure nodes in the first 10 vibration eigenmodes. The 3D model of the elevator bucket was introduced in ALGOR and automatically meshed, noting that the user can control the fineness of the mesh (this was set for the analyzed model to 50%).

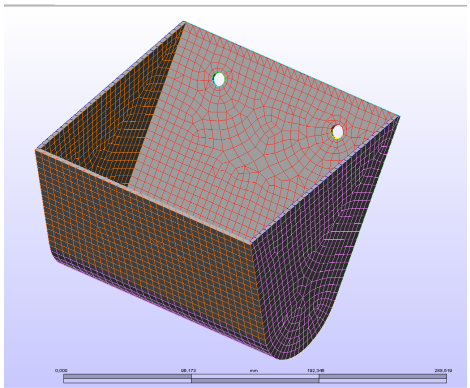


Fig. 5 The bucket meshing in Algor

After completing the meshing operation in ALGOR, the boundary conditions were specified (in this case it is necessary to define only a bearing set).

Thus, the elevator bucket has been embedded on the inner surface of the two holes (by fastening the screws of the bucket to the band) and elastically supported on the entire surface of settlement on the band. The value of the stiffness coefficient is 10 N/m.

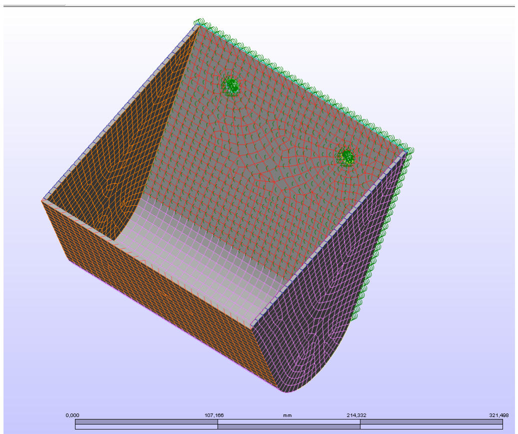


Fig. 6 The defining of the bearing set of the bucket

From the set of the obtained results, it is interesting to visualize the displacements of the structure nodes in the first 10 vibration eigenmodes.

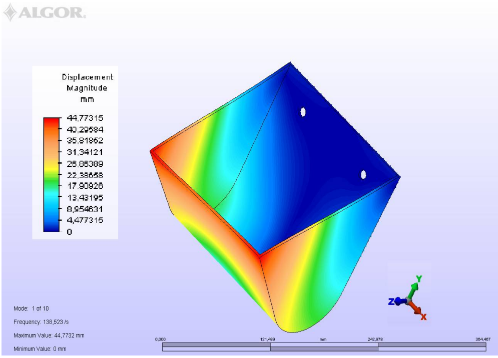


Fig. 7 The displacements of the structure nodes in the first vibration eigenmode

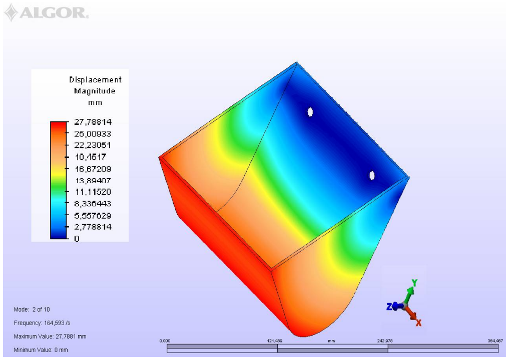


Fig. 8 The displacements of the structure nodes in the second vibration eigenmode

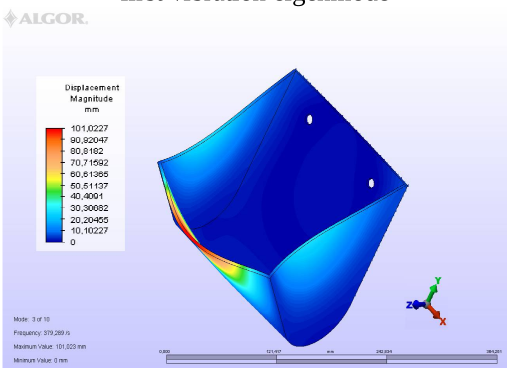


Fig. 9 The displacements of the structure nodes in the third vibration eigenmode

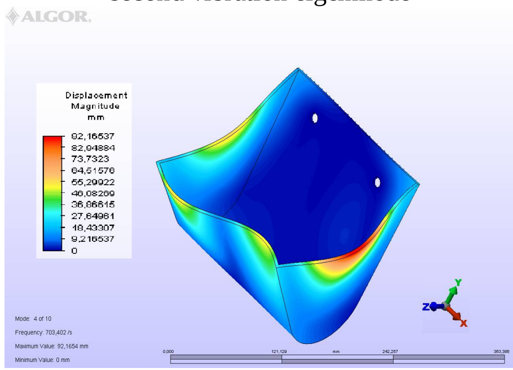


Fig. 10 The displacements of the structure nodes in the fourth vibration eigenmode

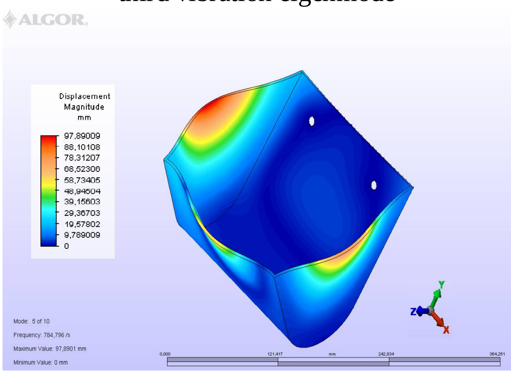


Fig. 11 The displacements of the structure nodes in the fifth vibration eigenmode

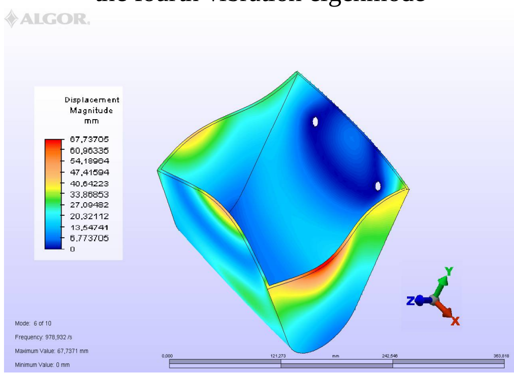


Fig. 12 The displacements of the structure nodes in the sixth vibration eigenmode

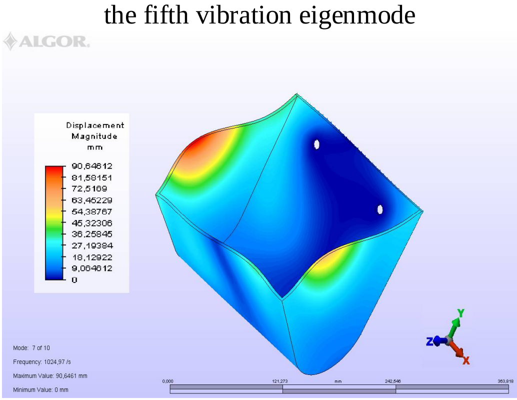


Fig. 13 The displacements of the structure nodes in the seventh vibration eigenmode

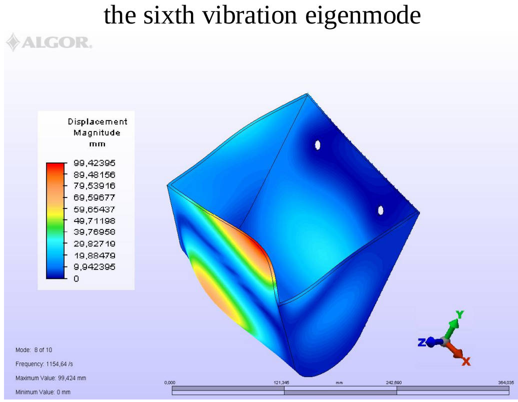


Fig. 14 The displacements of the structure nodes in the eighth vibration eigenmode

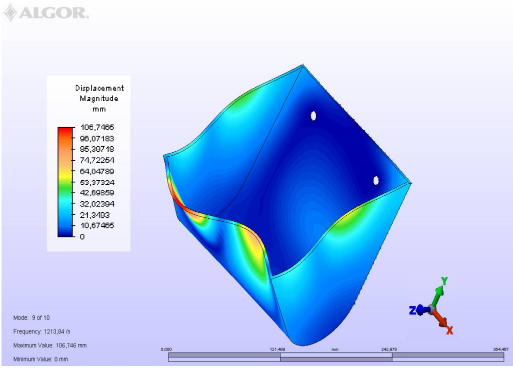


Fig. 15 The displacements of the structure nodes in the ninth vibration eigenmode

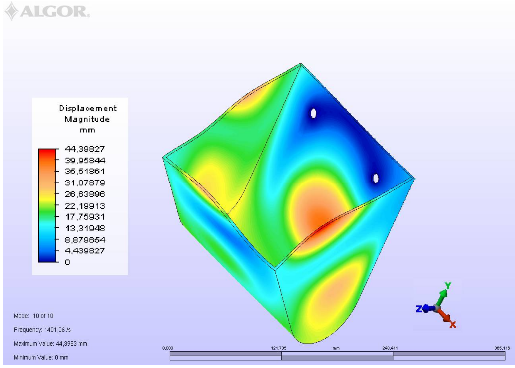


Fig. 16 The displacements of the structure nodes in the tenth vibration eigenmode

4. CONCLUSIONS

The analysis of the vibration eigenmodes of the elevator bucket was required by the need to estimate the domain of eigenfrequencies for such an item of working equipment.

These pieces of information are useful to highlight the potential occurrence of some resonance phenomena due to the overlapping of the frequencies generated by the dynamics of the working system and those from the eigenfrequencies domain of the structure.

REFERENCES

[1] **Bratu, P.**, *Analiza structurilor elastice. Comportarea la acţiuni statice şi dinamice*, Ed. Impuls, Bucureşti, 2011

[2] **Debeleac, C.**, *Interacţiunea echipament-mediu şi modelare dinamică*, Editura Galati University Press, 2015

[3] **Drăgan, N.**, *Vibraţii. Note de curs*, Facultatea de Inginerie şi Agronomie din Brăila

[4] **Dumitrache, P.**, *Modelarea structurilor de rezistenţă cu ajutorul metodei elementelor finite*, Editura IMPULS, Bucureşti 2003, ISBN 973-8132-36-5

[5] **Goanţă A. M., Bordei M.**, *Proiectare asistată de calculator*, ISBN 973-700-070-6, Editura Aius, Craiova 2005

[6] **Yashaswini, N., Raju. B, Purushottham, A.**, *Design and optimization of bucket elevator through finite element analysis*, International Journal of Mechanical Engineering (IIJME), Vol.2, issue 9, 2012

[7] **Loveykyn, V.S., Bortun, V.M.**, *Movement dynamics of bucket elevator with regard to its elastic and dissipative properties*, 2011

[8] **Oproescu, Gh., Anghelache, D.**, *Elemente de dinamica maşinilor de ridicat şi transportat*, Editura Galaţi University Press, ISBN 978-606-8008-71 – 4

[9] **Snehal Patel, Sumant Patel, Jigal Patel**, *A Review on Design and Analysis of Bucket Elevator*, IJERA vol. 2, issue 5, 2012, pp.18-22

[10]***http://www.gmagrotehnic.ro/elevatoare-cu-cupe/

[11]***http://www.ikosar.ro/benzi-pentru-elevator.html