THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XIV MECHANICHAL ENGINEERING, ISSN 1224-5615
2020

A COMPARATIVE STUDY OF THE EQUIPMENT FOR CRUSHING PILLARS AND CONCRETE STRUCTURES AND THE 3D MODELING OF A 6 – MODULE PILE BREAKER

Masterand Marius Stefan TUROSU
Prof.Assoc. Adrian Mihai GOANTA
"Dunarea de Jos" University of Galati - Romania, Faculty of Engineering and Agronomy in Braila, Research Centre for Mechanics of the Machines and Technological Equipments

ABSTRACT

This paper presents a comparative study of the equipment attached to the excavator arm intended for crushing and demolishing concrete pillars stiffened with metal reinforcement. The work also contains some details about the modelling of a pile crushing equipment using the German Solid Edge software from SIEMENS. The authors present both the hydraulic scheme of the mechanical shock generation mechanism and the result of the 3D modelling. The obtained results refer to the 3D models of each individual landmark, which will be further presented in detail in a future work together with the overall drawing and related execution drawings.

KEYWORDS: *pillars, sprayer, 3D modeling.*

1. GENERAL ASPECTS ON THE PILES CRUSHING EQUIPMENT ATTACHED TO THE EXCAVATOR ARM

Through the process of development and modernization of urban and rural areas, sometimes it is necessary to demolish isolated buildings, groups of buildings or even entire neighbourhoods [1]. Most often, demolitions are necessary to replace old buildings that cover large areas, with new modern buildings which, in addition to higher comfort, allow a better use of the land and enable the creation of an adequate urban landscape. In certain isolated situations, even buildings in good condition and relatively large must be demolished when the major systematization requirements call for it. Demolition works are carried out according to technologies and with common equipment usually used for this kind of work [2]. The executor of the demolition works will draw up technological data sheets for each building and individual operations in which he will specify the work method, the necessary machinery and equipment, labour protection measures, etc. The main technological demolition processes are: demolition with manual tools, demolition with mechanical devices and equipment, demolition with the help of explosives, demolition by percussion, demolition by breaking, demolition by expansion, demolition by abrasion, demolition by thermal processes, demolition by chemical processes, demolition by electrical methods, demolition with water jet. The most frequently used demolition procedure is the mechanized one that allows the demolition of several types of constructions. The advantages of the machines are not only the speed and precision achieved but also the safety, by removing the work force from the area where the work is carried out, these being necessary for productivity reasons. Another advantage is the recovery of materials such as: concrete,

steel, bricks, tiles, and ceramic material.

Demolition of a structure usually involves the fall of a lot of dust, metal and concrete, however, each demolition project is unique in its own way that is why there are several specific and specialized equipment depending on the type of demolition chosen. Demolition therefore requires careful consideration of the task to be accomplished and the machinery to be used. Depending on the size, location and environment of a demolition project, there are several types of construction equipment to choose from, but the most used equipment is the excavator. Excavators are usually stable, powerful, and highly efficient machines. They are usually used in conjunction with loaders and bulldozers. From small buildings to multi-story towers, excavators can easily be used for the demolition work. They can be used on various building structures such as steel, concrete and mixed materials. Basically, hydraulic excavators are used for demolishing small buildings while Long Reach excavators are used for demolishing larger buildings. Both hydraulic and long excavators have the ability to perform a number of different tasks using different attachments such as buckets, sprayers, claws, hammers, shears, crushers, etc. With a long arm, this powerful equipment is usually used for tough demolition tasks, where it is necessary to break walls, destroy pillars and solid structures.

2. COMPARATIVE STUDY OF THE SPECIALIZED EQUIPMENT ATTACHED TO THE EXCAVATOR ARM FOR BREAKING PILLARS

For the mechanized demolition of the pillars, several specialized equipments are used:

Pile breakers allow the breaking large reinforced concrete structures, resistance pillars, cutting and separating concrete structures from other recyclable materials and cutting metal structures, pillars, cars, pipes, tires. (Fig.1)

The pickax is like a hammer and is used to break reinforced concrete, boulders, or asphalt. (Fig. 2)

Multiprocessors are characterized by robustness and can carry out demolition and recycling works without changing the attachment, only changing the jaws. The jaws can be easily changed directly on the site, thus being able to perform several types of work with the same attachment. (Fig. 3)

A pillar breaker is used for demolishing reinforced concrete pillars, being 70% faster than a pickax.

Fig.1 Pile breaker

Fig.2 *Pickax*

Fig.3 Multiprocessor excavator

The pile breaker is known by the simplicity with which it operates: it "hugs" the pillar, breaks it, lifts the concrete remains, leaving behind clean and straight reinforcements, without causing cracks in the underground structure of the pillar. (Fig. 4)

Practice has shown that the pile breaker is the most efficient equipment attached to the

excavator arm for demolishing piles; due to its modular design, more 'piles' can be added or removed depending on the hydraulic capacity of the excavator, thus the inner diameter can be modified allowing the demolition of pillars of various diameters. At this moment in France, Great Britain, Holland it is mandatory to use this attachment for demolishing pillars.

Fig.4 Pile breaker

3. 3D MODELING OF THE EQUIPMENT USED FOR BREAKING PILLARS ATTACHED TO THE EXCAVATOR ARM

The 3D modelling of the assembly was carried out with the help of the 3D design and modelling software Solid Edge ST19 Student Edition offered by SIEMENS.

Solid Edge is a complete, intuitive, and affordable solution for digital product development, providing the best tools for design, simulation, visualization, manufacturing, and document management [3].

Combining the speed of explicit modelling with the flexibility and parametric control of the model, results in the fastest and most flexible modelling system: synchronous technology (ST), which is used for modelling each subassembly of the pile breaker and excavator. The method of construction as well as the operating principle of the 6- module pile breaker is illustrated in the following figure (Fig. 5). This constructive solution was the basis of the 3D modelling of the pile breaker made in Solid Edge ST19.

Also, the method of attachment of 6 simultaneous working chisels to the excavator arm suggests that the destruction of the pillar is done from the upper part to the lower part, thus providing an appropriate protection of the demolition area (Fig. 6).

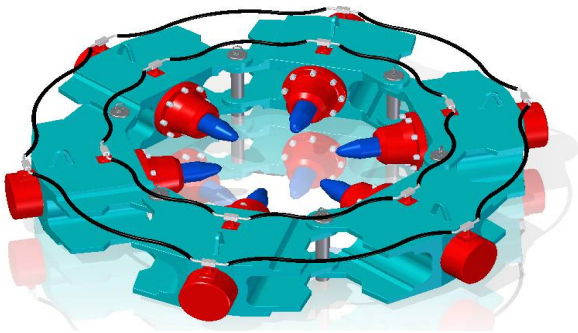

Fig.5 The 6- module pile breaker

Fig.6 The 3D model of the pile breaker attached to the excavator arm

In the following figure (Fig. 7) one can see the 3D model for the chisel/picamer that will be subjected to a finite element analysis, which simulates the deformation during a normal working regime, resulting from the application of a pressure of 320 bars. The dimensions of the chisel are standardized as 690 mm long. The steel used is also standardized, namely AISI S70, a steel with extremely good shock resistance, equivalent to DIN 17350-X45NiCrMo4 (+QT) or ISO 40NiCrMoV4.

The deformations and stresses are within the limits of the allowed values due to the adequate design (Fig. 8).

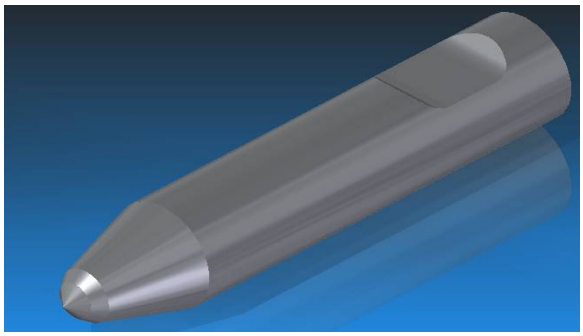

Fig. 7 3D model of the chisel

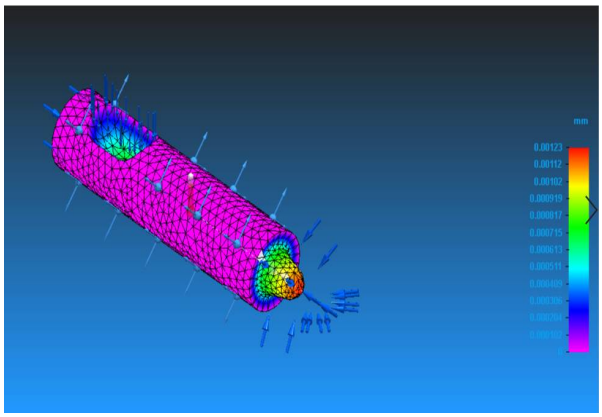

Fig. 8 Finite element analysis

4. THE HYDRAULIC OPERATION DIAGRAM OF THE TECHNOLOGICAL EQUIPMENT FOR THE GENERATION OF PICAMER MECHANICAL SHOCKS

This group includes the equipment generally used in the field of construction, being carried by construction machines and used for demolition works (buildings, roads, pillars, bridges, etc.) [4]. The functional principle of these equipments consists in the accelerated translational movement under the action of the hydraulic agent (mineral oil) of a heavy piston, called striker, which at the end of the descent stroke hits the work tool leaned onto the work medium. The application derives from the shutters of large-calibre automatic cannons, the first such equipment being produced by the German company Krupp.

The main characteristics of these equipments are the percussion energy and the percussion frequency. The paper will not insist on the dimensioning of these equipments that operate in a permanent dynamic regime dependent on many impact factors, specific to the working environment. The following figure (Fig. 9) shows the basic diagram of Krupp equipment, used as auxiliary equipment on small and medium capacity excavators (0,2-0,8m^3), manufactured by Liebher (Promex-Romania). The scheme is alike that of the Krupp hammer, but with improvements to avoid the hydraulic wears.

Notations used in the following figure. are the following: 1- striker, 2- body of the equipment, 3- working tool or spike, 4- working environment, A- upper chamber of the striker, B- lower chamber of the striker, C- internal control device of the equipment, P - pump coupling socket (equipment high pressure circuit), tank coupling T-socket (equipment low pressure circuit).

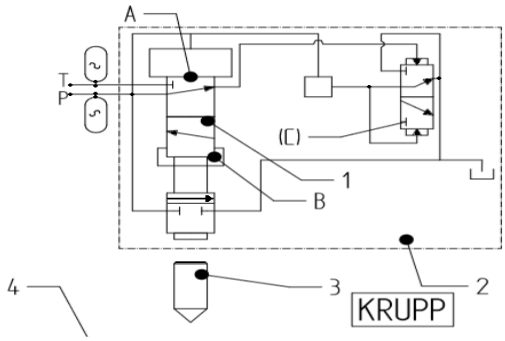

Fig. 9 Diagram of the Krupp hammer.

5. RESULTS AND CONCLUSIONS

The result of the -3D modelling is given in (Fig. 10).

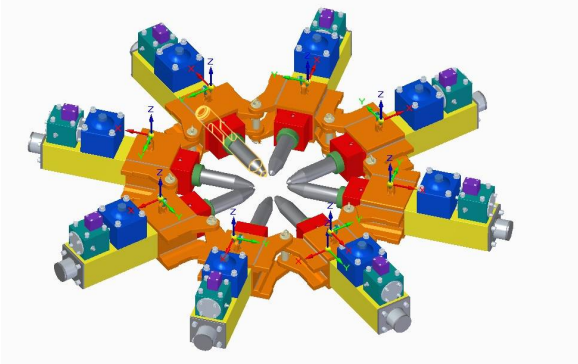

Fig. 10 The 3D model of the pile breaker

From the comparative study, it can be noticed that the best equipment used for demolition is the excavator, to which various equipment for demolition works can be fitted, thus resulting in stable, powerful, and extremely efficient machine. By attaching a pile breaker to the excavator, this becomes the most efficient tool for demolishing pillars, being 70% faster than a pickaxe and much faster than a worker. The 3D modelling of the equipment allows us to easily design it, being able to perform a finite element analysis of the landmarks, especially of the picker's chisel, which withstands all the shocks.

REFERENCES

[1] https://www.scribd.com/document/227460312/Tehnologia-Lucrarilor-de-Demolare.
[2] http://www.sinuc.utilajutcb.ro/SINUC-2009/SECTIA--III/9.III.21
[3] Gavril Axinti, Adrian Sorin Axinti. Acţionări hidraulice şi pneumatice: [pentru uzul studenţilor]: Chişinău: Tehnica-Info, 2008. 600 p., ISBN 978-9975-63-112-9
[4] Goanţă A.M, - Sisteme informatice de proiectare tehnologică – Laboratoare (Solid Edge v20), Universitatea "Dunărea de Jos" din Galaţi, Facultatea de Inginerie din Brăila, 2009