ÚJ ELRENDEZÉSŰ TELESZKÓPOS KOTRÓGÉP TERVEZÉSE

NEW CONCEPTION DESIGN OF TELESKOPIC EXCAVATOR

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ÖSSZEFOGLALÁS

A mobil munkagépek fejlesztésének egyik iránya a sokoldalú kihasználhatóság biztosítása. Több technológia kiszolgálása nagyobb mobilitást is követel a munkagéptől. Megoldás az univerzális munkagép. A cikk egy ilyen munkagép tervezését mutatja be. A Szlovák Műszaki Egyetem gépész és az Építesz Kar formatervező hallgatóinak közös, irányított munkája. Gépészek a mobilitás követelményeinek jól megfelelő, külön meghajtású alvázat, valamint flexibilis szerszám-felszerelésű teleszkópos munkafel-építményt terveztek, a formatervezők egy újszerű formába öltötték a műszaki megoldást.

1. INTRODUCTION

Thanks to technological progress, development of new technologies and work mechanization activities, the work in building production and communal sphere is easier and more effective. Currently, telescopic excavators are applied in the field of communal and road machines. Their specific parameters find a special status in the mechanisms used for maintenance of roads and their dealing with the terrain.These machines quickly found their position in the field of construction and land reclamation and planning due to the advantages they are offering. High performance, versatility, stability, low operating cost, high impact and large scale of working devices predetermine these machines to the wide use in construction work in any terrain.

The telescopic excavator *SUS Scrofa* is, due to its unique parameters, able to replace the work of several types of machines. Its main task is the final modification of surrounding terrains of buildings. This telescopic excavator can be used for scarification of soil type 2, 3, 4 and curing of roads. The design of the machine is divided according to the idea of modularity into several smaller units, which can be further adapted to expand the field of machine application. The methods used in designing solutions to various parts are commonly used in the automotive industry. Individual structural nodes are conceptually and structurally processed in programs CATIA, AutoCAD and 3D Studio Max. The content of this project is to better explain the issue of a new generation of telescopic excavators, clarify the principles of operation of a specific class of telescopic excavators and propose the possibilities of application in the field of building, servicing and repairing of roads, too. The designers of this machine managed to create a structure which is unique in its conception, whereby the modularity of components was also taken into consideration. After some design modifications the rotary top can be used as a part of the automobile chassis or another type of carrier. The real plane is the possibility of using work device to a different type of rotary top.

Fig.1 Telescopic excavator SUS Scrofa

2. UNDERCARRIAGE

The chassis of the proposed 30-ton telescopic excavator is solved by 8-wheel 4-axle arrangement with only two of them being driven (Fig. 2).

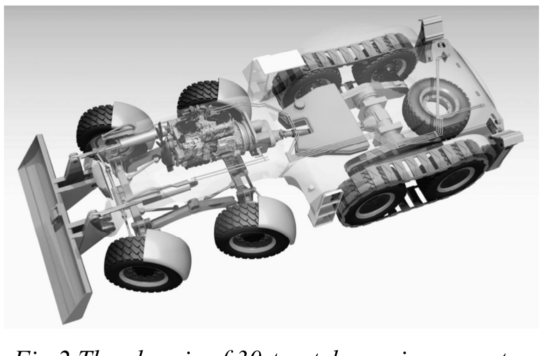

Fig.2 The chassis of 30-ton telescopic excavator

The chassis power unit is chosen so that it allows to maximally reduce the cost of production and therefore is consistent with the type, which serves to drive sets of the superstructure. In addition, the transmission can be taken from the world renowned manufacturers which can be tailored directly for the intended use. This possibility saves the investments necessary for its development.

Both axles are of a tandem type which means that a pair of wheels on one side of the axle is freely swinging around the axis at mid distance. That concept was not chosen at random. The advantage of this structure of the rear axle offers the opportunity to use belts (rubber or steel) on the rear wheels, making excavator handling in the field much easier.

The design of the front axle consists of two identical axles suspended by two pairs of bolts for the rocker. Besides, the lower pin in the stirrups is also free to pivot around the longitudinal axis of the hole in the rocker. The movement perpendicular to the direction of driving is prevented by two pairs of stretches imposed at both ends of the ball pins to ensure symmetrical cone movement.Advantages of the front tandem axle can be in practice best verified during the transport of the excavator on road. If you by now for transport of an excavator of a comparable weight category needed a trailer, this problem was resolved with a view to reducing the cost of handling the machine (Fig. 3).

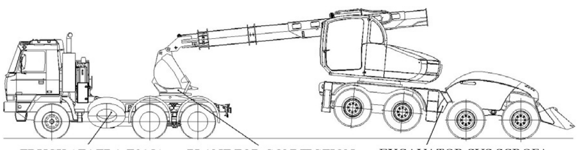

Fig.3 Road transport process
of excavatar SUS Scrofa by truck

Before the transport the excavator working device is turned backward. The shovel is equipped with an adaptor allowing its connection to a conventional truck unit through the turntable for towing trailers. Being connected, the excavator will lean on the tractor and lift the rear axle. After fixing the position of the working device against depression is the backhoe ready for transport. The machine will behave like a trailer and the total length of the set will not exceed 18 meters. Another of the many benefits of the machine is hydraulic autonomy of the undercarriage from the rotary top. The motor, driving unit of the transmission system, can be used before the beginning of the work for driving of a simple oil pump which adds liquid to the stabilization components of the carriage or additional attachment (sweeper mechanism, snowplow, additional road miller) mounted on a plow. After the chassis stabilization, the motor is turned off and active is only the rotary top.

In conventional machines the chassis is powered hydrostatically, which results in large losses in the energy transmission. Moreover, it is necessary to equip the machine with a complicated rotary hydraulic converter. The concept of *SUS Scrofa* machine is a vision how might the future machines look like. Modification of a self-propelled and automotive chassis is a way to transfer data from turning top to the undercarriage (Fig. 4).

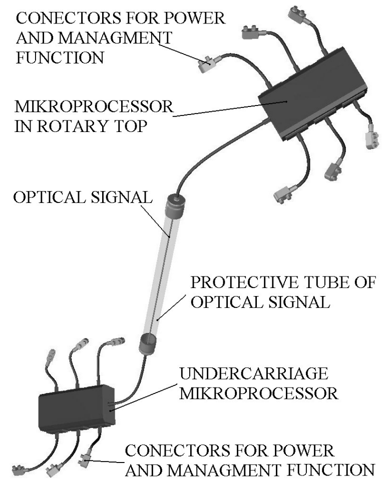

Fig.4 Rotary converter of optical signal

Machines currently used in this situation are dealt with rotary converter, through which all hydraulic and electrical commands pass to the chassis. This application brings in the category of more powerful machines a lot of problems, such as the transmission of many hydraulic routes from the superstructure to the undercarriage. This explains the absence of wheeled chassis for mobile machines in the weight class of 30 tones. The *SUS Scrofa* machine eliminates the need to use a rotary converter, since all control commands are transmitted to the chassis by optical signals. The commands from the operator cab are encoded by a microprocessor and via an optical corridor, passing through Slewing rings center, are transmitted to the undercarriage. Here the signals are decoded and executed.

By using optical signals for the management of chassis functions the possibility of integrating chassis and control of hydraulic functions in one space arises. For automotive chassis excavators the management concept with own cab was used, which means the creation of two posts for the operator. This method of the chassis functions control has resulted in connection of the rotary top to the undercarriage with only fixing bolts of large slew ring. The resulting benefits are several. The machine divided into the chassis module and turning tracks can be easily dismantled without release or venting of hydraulic circuits. The machine can be easily transported in height confined spaces including the possibility of transport by Hercules C130 plane, which becomes an interesting option for use in the army. Rotary tops can be changed according to current needs. One chassis can serve a number of upper structures (crane, recovery crane, rocket carrier) and vice versa. By unifying control signals of the manufacturers the chassis could be controlled from various swing uppers.

3. ROTARY TOP

The rotary top consists of a frame on which propulsion units, car handling and work equipment are located (Fig. 5).

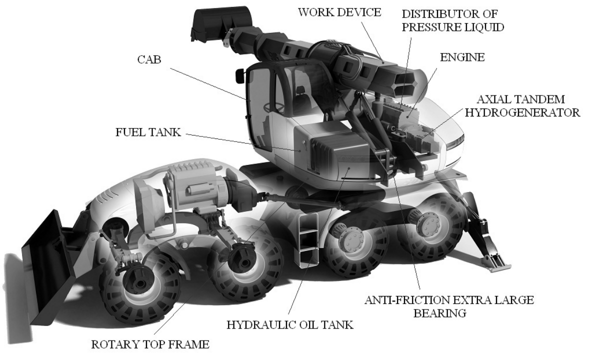

Fig.5 Deploy of main parts

A design of the machine was needed which would cope with the effects of work, workplace safety, performance and operational reliability. So an important design requirement was to deploy all efficient mechanisms and accessories to supporting frame of the rotary top. The particular elements are designed with regard to current trends in mobile working machines.

The working device is the most important part of the rotary top. Its excellence lies in the unique shape of internal and external telescopic booms, the system of component placing in the hub and other innovations designed to increase durability, reliability and economic efficiency. A big advantage of the telescopic excavator is its digging force (Fig. 6). It does not depend on the reach, but it is constant along all range of digging activities. An important feature of the machine is its ability to work in confined spaces (Fig. 6). This was achieved by minimizing the "dead" workspaces. The possibility of minimizing was achieved by a fundamental feature of the work equipment - linear motion. The advantage of minimizing the idle space is required particularly for machines used in the municipal sphere.

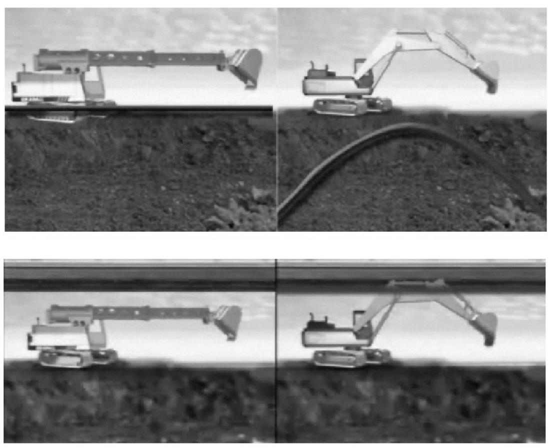

Fig.6 Process of digging force and working in confined spaces

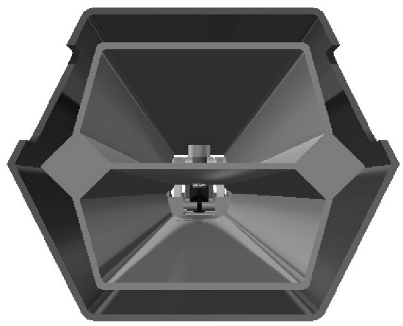

Fig.7 The telescopic boom shape

The boom shape (Fig. 7) is designed to withstand more stress (thanks to optimal pressure layout) than the commonly used shapes of these structural components.

In practice, this property reduces the weight of the biggest part of the rotary top and retains its original work performance. The main parts of the boom are two square profiles. Plates in the hexagonal shape are fixed to these profiles by welding. For the stiffness of the system a plate is put between two square profiles. It prevents deformation of the boom.

The moving between external and internal booms is achieved by rolling in the front ring and slides in the rear ring of the external boom. The boom is fixed to the hub at two places. Thus, all its degrees of freedom are taken away except the rotation around its own axis. The uniqueness of placing lies in the combination of an anti-friction extra large bearing with the external teeth, placed in the front part and sliding bearing in the backside. The plate, which serves to attach the front bearing on the boom is structurally designed so that there is a slight shift in the boom axis. The task of this version is to prevent unilateral stress of the front bearings and leave a substantial part of the load on the rear sliding bearing. The rotary hydromotor that serves to rotate the working equipment in the range + / - 110^{o} is attached at the bottom of the hub. The overhang of hydraulic hoses that are supplying oil to the working equipment is a limiting factor in the boom rotation. The working device is handled by couple of straightforward fluid hydromotors which are mutually eccentric. The advantage of this placing consists in the mutual support by keeping the constant performance in the extreme positions.

4. CONCLUSION

As far as we observe the development tendencies within the area of mobile working machines, we can say that the universal working machines with high readiness of utilization and possibility of a fast transport between workstations are the most demanded ones at the market. The *SUS Scrofa* telescope excavator of a new concept, covering the wide scope of utilizing technologies fulfils all of these requirements and for its own technical parameters is ranged between modern, effective and competitive solutions.