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Assembling of Steel Angle Headframe of Multifunctional Purpose

E G Kassikhina [a], V V Pershin, V M Volkov

Mining Institute, FSBEIHE (Federal State Budgetary Educational Institution of Higher Education) T.F. Gorbachev Kuzbass State Technical University,
28 Vesennya Str., Kemerovo, Russia, 650000

E-mail: [a] kalena-07@mail.ru

Abstract. The article reviews new technical solution on equipment provision of vertical shaft utilizing steel headframe of multifunctional purpose. Practice of construction of coal and ore mines provides application of various designs for steel angle headframes which are divided into separate large assembly blocks and constructive elements during assembling operations. Design of these blocks and elements, their weight and dimensions effect the chose of the method of assembling on which economic and technological indicators, as well as duration of down-time, depend on during performance of construction operations in shaft. The technical solution on equipment provision for mine vertical shaft using headframe of multifunctional purpose will allow changing the management construction of vertical shaft. The proposed headframe combines the functions of sinking and operation that eliminates costs for assembling/dissembling of temporary headgear. The constructive design of the headgear allows application of the effective method of assembly and thus to provide improvement of the technical and economic indexes, and high calendar time rate of the shaft construction due to reduction of duration of works on equipment provision for the shaft and to refurbishment of the shaft in order to carry out horizontal mining.

Introduction

The construction project of the vertical mine shaft consists of the following main stages: provision of equipment for mine surface and sinking of the technological part of the shaft (including shaft collar); provision of equipment for surface for a shaft sinking, including assembling of the sinking headgear; shaft work; shaft walling; refurbishment of the shaft to carrying out horizontal and inclined developments, including dissembling of headgear unit during sinking operations and, construction of the permanent headframe [1 –6].

Object of survey. The method of assemble of headframe significantly impacts the entire construction schedule of a mine as the duration of the shut-down in a shaft depends exactly on it.

The practice of construction of the coal and ore mines provides various designs for the steel angle headframes, both sinking headgear and permanent headframe: 4-post headframe, 4-post headframe with two stay legs, tent headframe and two-post headframe which are divided into separate large assembly blocks and constructive elements during assembly operations [1 –10].

Method

Depending on the constructive design of these blocks and elements, their weight and dimensions they choose a method of assembly on which economic and technological indicators, as well as duration of shut-downs during construction works in shaft depend.

Aim of survey. 'Construction of Underground Structures and Mines' department at KuzSTU developed technical solution regarding furnishing of the vertical shaft with equipment utilizing steel headframe of multifunctional purpose [11, 12, 13] what will allow to change mining management on some of the hereinabove mentioned stages.

Results

As the proposed headframe (fig. 1) due to assembly/disassembly of the replaceable functional blocks combines the functions of both sinking and operation, then such stages as disassembly of gear complex during sinking operations and construction of the permanent headframe will be eliminated from the schedule.

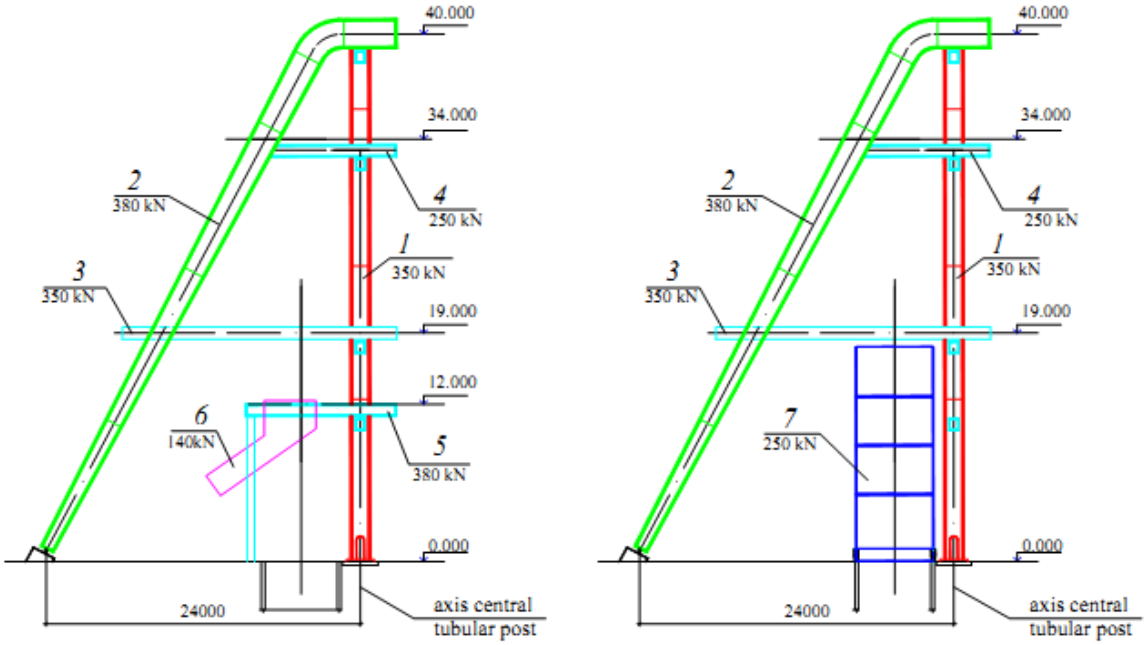


Fig. 1. Breakdown of the headgear on blocks: a –scheme for sinking period; b – scheme for operation; *1* – central tubular post; *2* –stay leg; *3* – sheave wheels platform; *4* – permanent sheave wheels platform; *5* – unloading machine; *6* – reception bunker; *7* – rig

The assembly of the headframe is carried out in the following consequence. On the assembling stand (fig. 2) located in the close proximity from the constructing shaft, the assembly is performed in horizontal position of the central tubular post (block #1). The assembled post is pulled to the shaft by sliding using two valves working as masts, erected to the vertical position and installed on the foundation as per the project position (fig. 3, a).

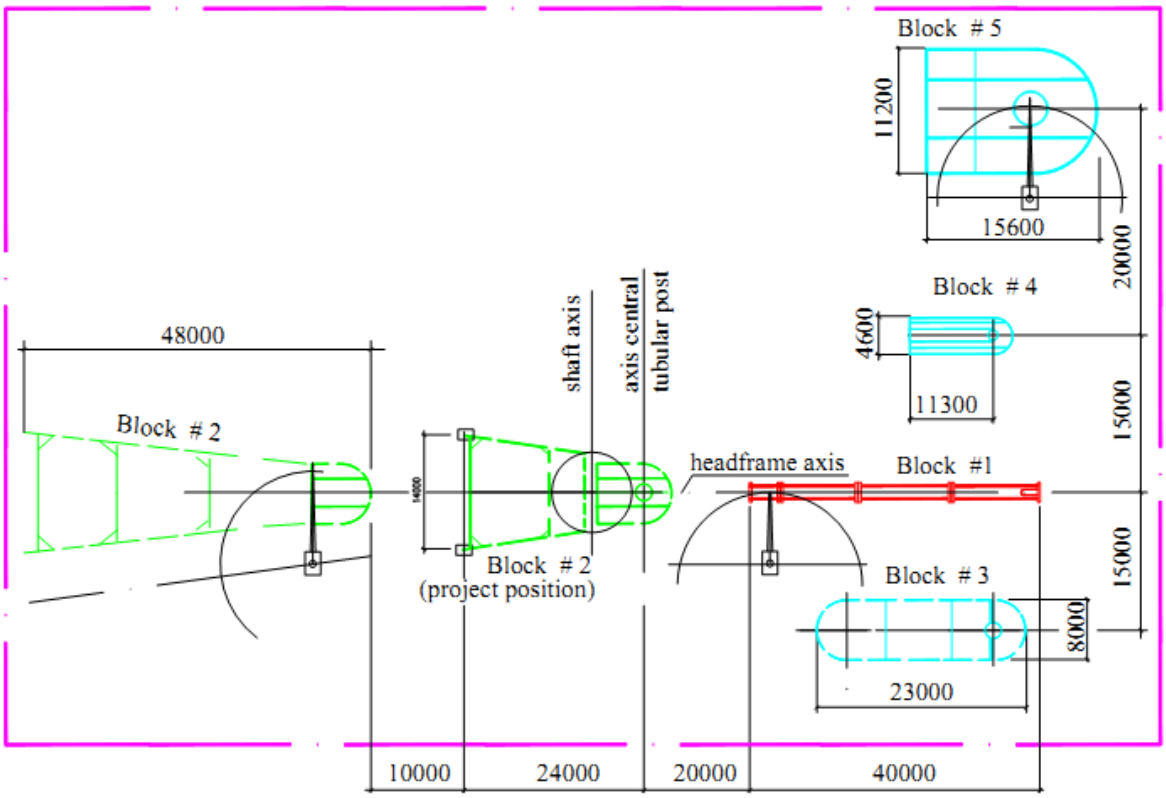
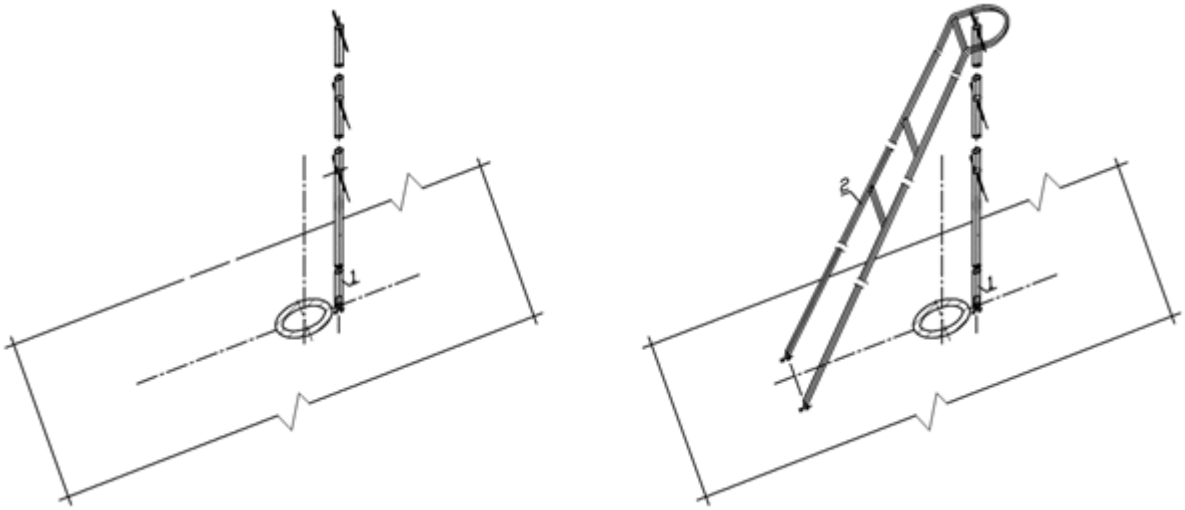


Fig. 2. Assembly schedule for blocks of the headframe

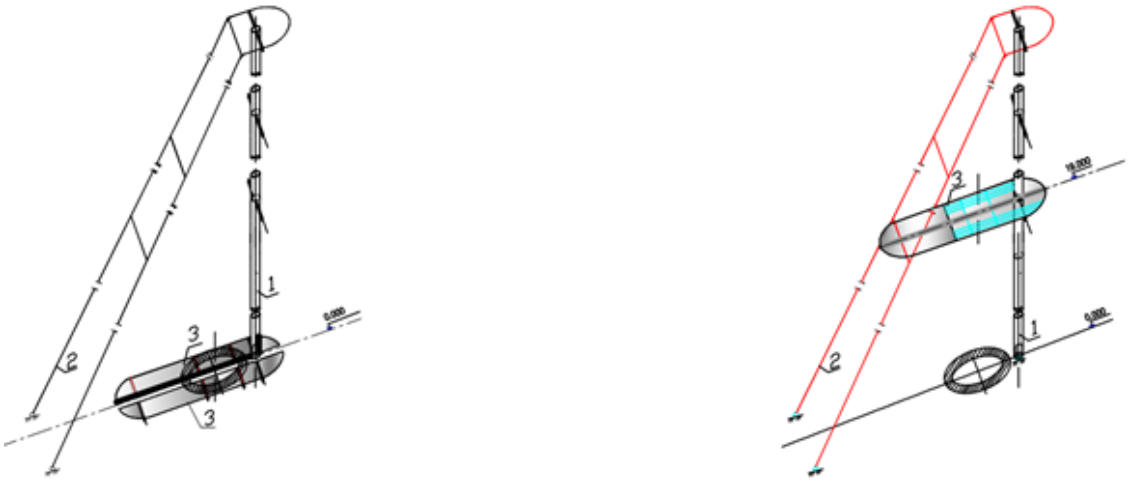
On the assembly stand (see fig. 2) they perform pre-assembly of stay leg (block #2) in horizontal position with the subsequent movement by sliding to the shaft by two cranes, there it is erected to the project position and fixed on the central tubular post *1* (fig. 3, b).



a) b)

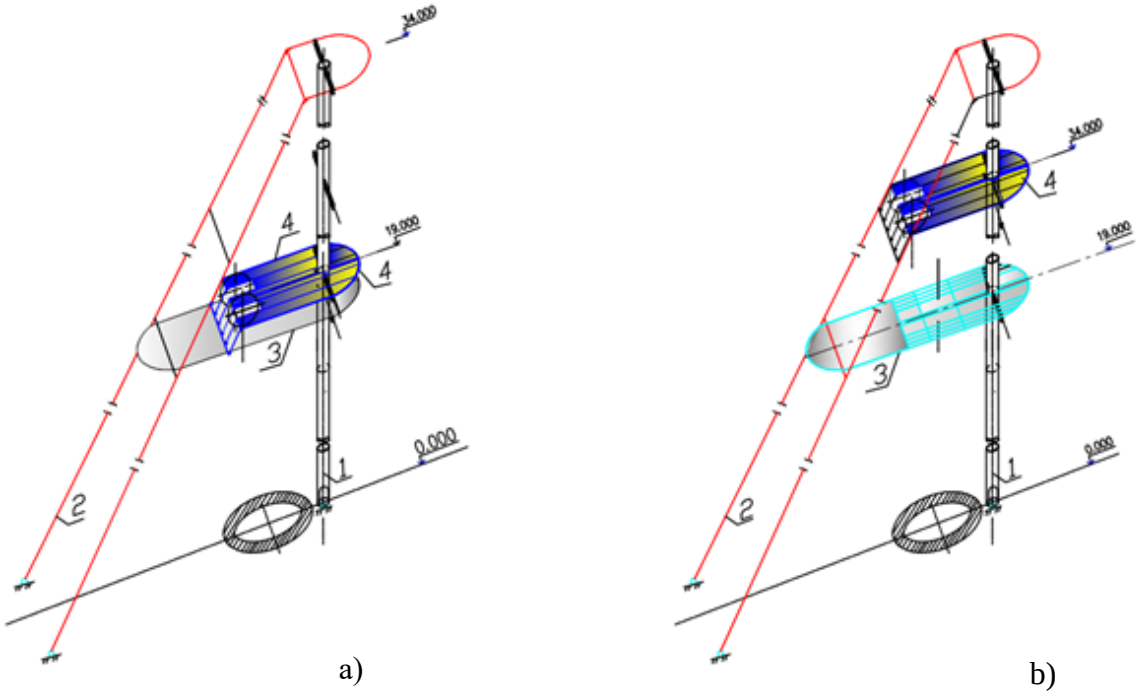
Fig. 3. Scheme of assembly of pulley device: a – erection of central tubular post; b – assembly of stay leg; *1* – central tubular post; *2* – stay leg

The driving sheave wheels platform (block #3) is put together on the assembly stand in the form of two blocks, each of them is separately moved to the position 'on the ground' on the level ±0.00 m where they are connected to each other (fig. 4, a). By two cranes using the central tubular post *1* as a guide, the driving sheave wheels platform *3* is erected to the project position (fig. 4, b).



a) b)

Fig. 4. Scheme of assembly of the driving sheave wheels platform: a – assembly on the ground; b – lifting to the design position; *1* – central tubular post; *2* – stay leg, *3* – the driving sheave wheels platform



a) b)

Fig. 5. Scheme of assembly of permanent sheave wheels platform: a – assembly on driving sheave wheels platform; b – erecting to project position; *1* – central tubular post; *2* – stay leg, *3* – driving sheave wheels platform, *4* – permanent sheave wheels platform

The permanent sheave wheels platform (block #4) is put together on the assembly stand also as of two blocks, each block is moved and placed on the driving sheave wheels platform *3* by two cranes (fig. 5, a). On the driving sheave wheels platform *3* they perform the final assembly of the permanent sheave wheels platform *4* from the two enlarged blocks and erect it up to the project position (fig. 5, b). The lifting is carried out by two cranes using the central tubular post *1* as a guide.
The assembly of the enlarged block #5 (the driving unloading platform) is performed as per analogy with the assembly of the block #3 (the driving sheave wheels platform) with the subsequent erection of the bunker (block #6). At this stage of assembling of the winch on the level 40.000 m is already possible for the elevator moving inside of the tubular post *1* which can be in turn used for needs of assemblers.
After a long break when mining and walling of the shaft are complete, it is necessary to dissemble the unloading machine and the receiving bunker, part of the driving sheave wheels platform and the mining equipment to assemble the unit (block #7) (see fig. 1).
The unit *5* [15] consists of ring elements *6*; each element is separately moved and stack on the driving sheave wheels platform *3* for the subsequent assembly by the 'from up to down' method over the shaft collar *7* (fig. 6). Thus, the driving sheave wheels platform is used again as assembly and installation platform already during transition to the operation mode.

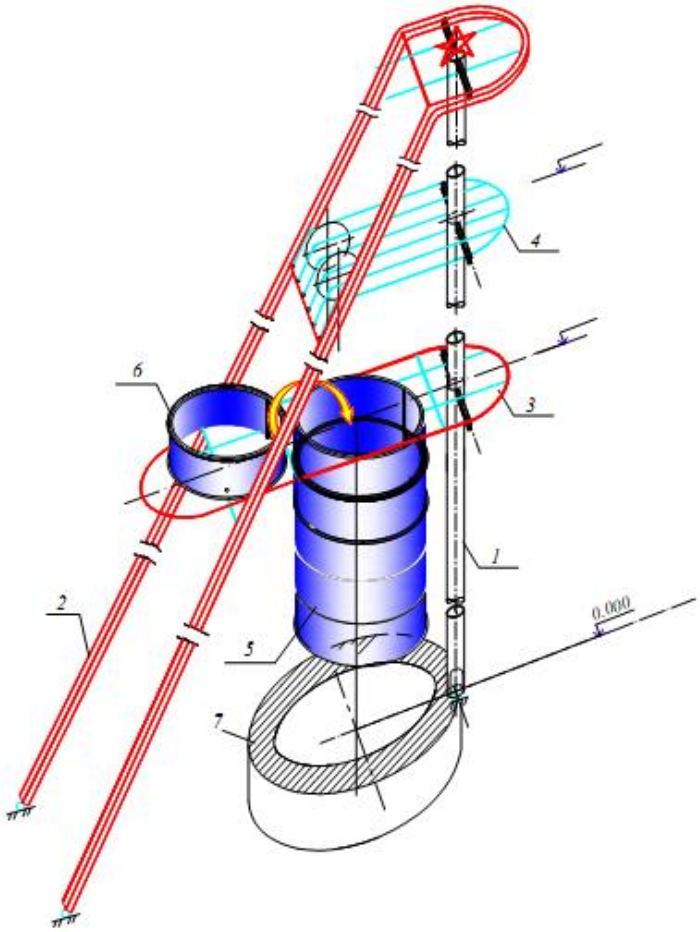


Fig. 6. Scheme of assembly of driving sheave wheels platform: *1* – central tubular post; *2* – stay leg, *3* – driving sheave wheels platform, *4* – permanent sheave wheels platform, *5* – rig, *6* – ring element, *7* – shaft collar

The efficiency of the suggested method of assembly of the headframe of multifunctional purpose is provided by:
– Reduction of the total time for assembling of the headframe and, in this regard, considerable reduction of shutdown during operations in shaft, considerable reduction of the overall labor costs and the cost of headframe assembly;
– Reduction of labor input and cost of installation due to breakdown of the headframe on the assembly blocks of small weight (250 kH - 350 kH);
– Application of the sheave wheels platforms for assembly and erection;
– Use of the central tubular post as a guide what considerably reduces the number of operations on aligning and adjustment of structures during assembling;
– Reductions of labor costs on rigging up of the unit which is put together separately from the sheave wheels platform and other constructive elements of the headframe;
– Lack of labor costs on arrangement of the rolling track to deliver ring elements of the rig to the place of installation due to their small weight;
– Minimizing of works at height.
The suggested option of the vertical shaft construction utilizing headframe of multifunctional purpose versus the traditional technical solution [1-7] allows to reduce labor input of assembly operations in 1.5 times, duration of works in 1.22 times, steel consumption in 1.5 times (table 1).

Table 1

Index	Sinking headgear ‘Sever-1’ (excluding dissemble)	Permanent angle headframe	Headframe of multifunctional purpose
Labor input of assembly МК, man/hr.	95.9	153	174
Assembly duration as per time-table, days	20	25	15
Steel consumption, kN	1200	1890.5	2060

Conclusion
The technical solution on equipment provision for the mine vertical shaft utilizing headframe of multifunctional purpose will allow changing of the arrangement of construction operations in vertical trunk. The proposed headframe combines the functions of sinking and operation that eliminated costs for assembling/dissembling of the temporary headgear. The constructive design of the headgear allows application of the effective method of assembly and thus to provide improvement of the technical and economic indexes, and high calendar time rate of the shaft construction due to reduction of duration of works on equipment provision for the shaft and to refurbishment of the shaft in order to carry out horizontal mining.

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