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University POLITEHNICA of Bucharest, Machine and Manufacturing Systems Department
Bucharest, Romania

TAMPING TOOLS

Sorin George BADEA, Cristinel BEŞLEAGĂ, Constantin MINCIU

Abstract: *The tamping tools are special tools which are used for building and maintenance of the geometry and the resistance of the railway. The researches in specialized literature regarding to present stage of the researches, designing, manufacturing and exploitation of the tamping tools have shown a low level of information and technical details regarding these types of tools. The collected information is in the most cases summary information, with general character and especially commercial, with few references at dimensions, geometrical shapes of different parts and surfaces of the tamping tools, of the reciprocal positions, the qualities of surfaces, the materials and technical process used to manufacture the tamping tools.*

Key words: *tamping operation, tamping tools, tine geometry.*

1. INTRODUCTION

Tamping is the technological operation of realizing a support of ballast under the inferior part of the sleeper, with the main purpose to assure a specific geometry [1, 2] and resistance of the railway (Figs. 1 and 2). Tamping is being executed with the help [1, 3] of the tamping tools (type: BNRI – 85, Matisa, P&T 08 – 275 UM, P&T 09 – 32 CSM and so another).

Mechanized tamping consists in the vibration (oscillation) and squeeze of the ballast under the inferior part of the sleeper, at frequencies by 35 Hz, amplitude of the oscillation is 3÷5 mm and the force is 10 KN.

The tamping tools are mounted on the tamping mechanisms (Fig. 1) and they are mounted on the tamping machine. The tamping tool is working similarly as the cutting tools [4], with the difference that during the technologically tamping process doesn't results splinters, but is taking place the vibration (oscillation) and squeeze of the ballast under the sleeper (Figs. 1 and 2).

By the construction, quality and the lastingness of the tamping tools depends, in the most of the cases, the quality of the tamping operation, because the tamping tools are the final elements in cinematically chain of tamping machines.

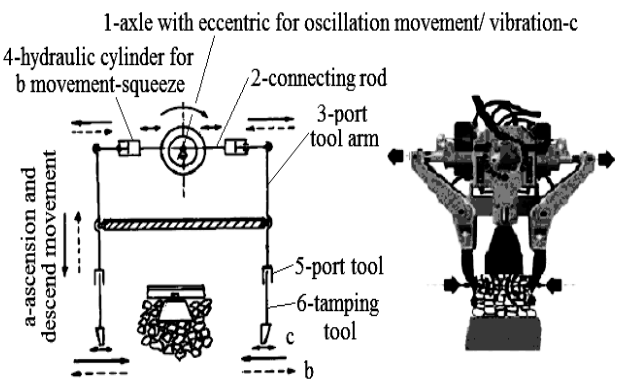


Fig. 1. Tamping mechanism.

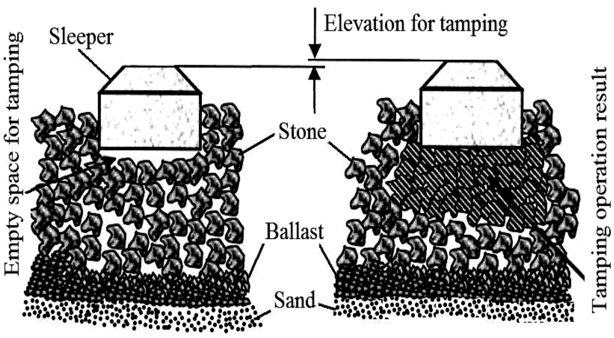


Fig. 2. Tamping results.

2. TAMPING TOOLS

2.1. Tamping tool's elements

A tamping tool (Fig. 3) has the follows elements, through analogy with the cutting tool:

- the body of the tamping tool, which are included also the part of the tamping tool for to attach at the port tool;
- the active part of the tamping tool, which has a different name like tine, pad, blade and so another.

The body of the tamping tool is supporting the active part and helping to fix the active part into the port tool and to transmit the working movements.

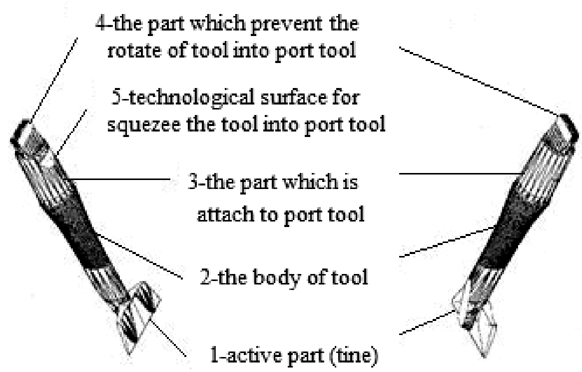


Fig. 3. Tamping tool's elements.

2.2. Tamping tools types

In the world are use many types of the tamping tools which are included many types of assembling. Some of them are presented below, with their particularity.

Johansson – Sweden solution [5] is present in Fig. 4. His particularity is a dismountable assembling between the body of the tamping tool and the active part of this (tine, blade).

A Plasser solution (Austria) [6] is present in Fig 5. His particularity is a removable tine (blade) from the body (shaft) of the tamping tool.

Crowell – U.S. solution [7] is present in Fig. 6. His particularities are using a special shape for the body and the tine (blade) with certain positions between them and the axle of the tamping tools, using the tungsten carbides and a special method for applied at the surfaces which are exposed to abrasion wear.

Richard – U.S. solution [8] is present in Fig. 7. His particularities are using more bodies from tungsten carbides, with a special geometry and which are positioned at the end of the tine (blade) where the abrasive weariness and shock is intensive. The protection at the abrasive weariness and shock is on the front and rear surfaces.

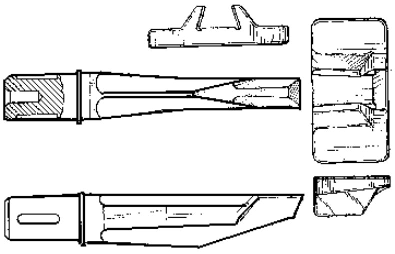


Fig. 4. Johansson – Sweden tamping tool.

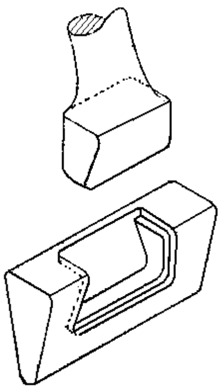


Fig. 5. Plasser – Austrian tamping tool.

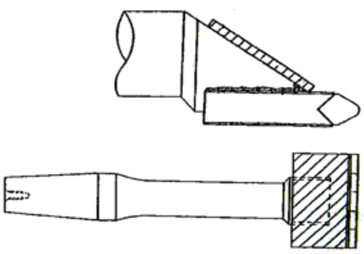


Fig. 6. Crowell – U.S. tamping tool.

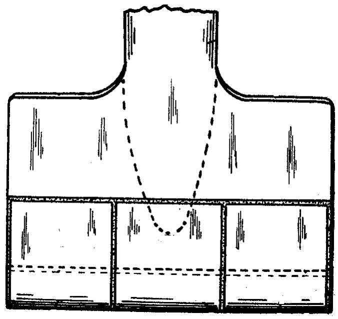


Fig. 7. Richard – U.S. tamping tool.

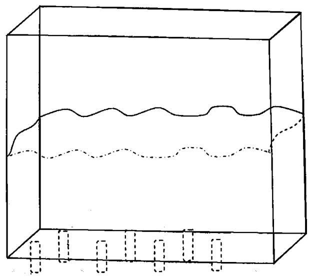


Fig. 8. Glenn – U.S. tine (blade) for tamping tool.

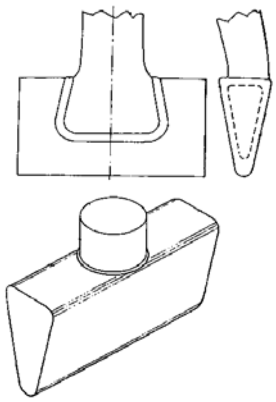


Fig. 9. Ruban – Russia tine / pad for tamping tool.

Glenn – U.S. solution [9] is present in Fig. 8. His particularities are using hardened steel for tine (blade or pad) and a wear resistant coating covers. The wear resistant bodies are placed at the inferior side of the tine, where absorb the shock and reduce the abrasive weariness.

Ruban – Russia solution [10] is present in Fig. 9. His particularities are using a special casing from wear – resistant material, for increasing the abrasion resistance of the tine / pad of the tamping tool, and the core material for filling the tine / pad casing. The core material of the tine / pad is used for attach the tine / pad to the body of the tamping tool through welding.

Williams – U.S. solution [11] is present in Fig. 10. His particularities are using a many various arrangements from bodies of wear – resistant material which are placed in all zones which are exposed at the abrasive wear and shock. It has also a special geometry at the end of the tine because the geometry of the bodies are specifically, and the wear – resistant material cover the front surface, the rear surface and the lateral surfaces.

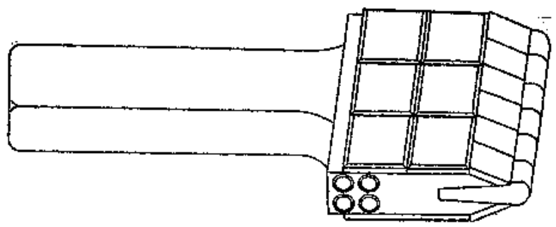


Fig. 10. Williams – U.S. tamping tool.

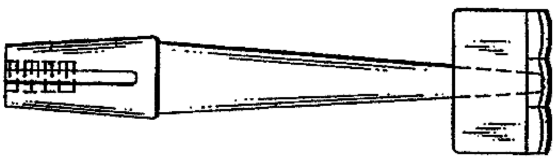


Fig. 11. Isakov – U.S. tamping tool.

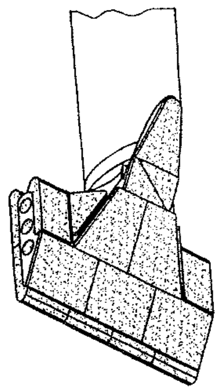


Fig. 12. Tamping tool for Plasser &Theurer tamping machine.

Isakov – U.S. solution [12] is present in Fig. 11. His particularities are using a plurality of insert bodies which are resisted at abrasive wear and shock (carbides material). The insert bodies are rigidly positioned therein at the end of the tine/ blade. The shape of the leading edge is bending between the opposed shoulders. Each insert body has a leading edge with a radius and from this composition result the leading edge of the tine / blade.

Another solution for the tine / blade of the tamping tool for Plasser & Theurer tamping machine is present in Fig. 12. His particularities are using a special case / cover for tine/ blade from wear – resistant material, for increasing the resistance at the abrasive wear and shock. This case/ cover are composed from many and variously shapes of bodies which are attached rigidly at the tine/ blade.

In the experimental researches, for the first time in Romania, we have realized and use the types of tine / blade which are presented below (Figs. 13, 14 and 15).

We have used for this, the covering with bodies / plates from metallic carbide (which have different shapes, dimensions, positions) of tine / blade of the tamping tools, using hard paste process (brazing). We have selected and tested the bodies / plates from tungsten carbides type (group) G, subgroup G 40. They have good properties for shock and bending. Among hard paste process (brazing), we have selected the brazing through induction with currents by high frequency (10^5 Hz).

3. THE GEOMETRY OF THE ACTIVE PART

3.1. The constructive geometry

The geometry of active part of the tamping tools is similarly in many ways with the geometry of cutting tools, existing some significant different. For to study and research the geometry of the active part of the tamping tools, we have defined, the constructive and the functional reference systems of these.

When it is tamping a sleeper, the tamping tines penetrate into the ballast and perform a closing movement, called squeezing.

Theoretically, the constructive sharp angle $\beta = 0°$, so the penetration can be made easier. Practically, the sharp angle is $\beta \neq 0°$ (Fig. 16).

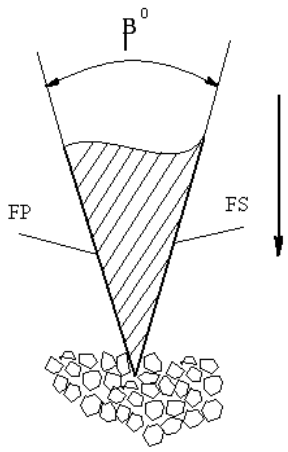
Regarding to the geometry, the surfaces and edges of active part of the tamping tool can be engaged in different relatives' position in the space, which is defined by the angle made with the axis of a rectangular reference system.

These angles could be indicated in comparison with a constructive rectangular reference system or a functional (real) rectangular reference system [4].

In comparison with the constructive rectangular reference system, which is the reference system of the tamping tool, must be indicated the necessary angles for the construction, reconditioning and measuring the geometry of active part of a tamping tool.

The axis and the geometry planes of the constructive rectangular reference system are defined by (Fig. 17):

- *O* – point of the edge of active part of the tamping tool where the geometry is measured;
- *Oy* – the axis that is represented by the axis on which is attached the port tool, which is passing throw measure point O;
- *O*z – the axis that shows the tamping direction;
- *Ox* – the axis which is perpendicular on *Oyz* plane (the constructive measure plane);
- *Oxy* plane – is the constructive basic geometry plane which passes throw measure point *O* and is perpendicular on the tamping direction;
- The constructive edge geometry plane *Oxz*, which contains the constructive edge or the tangent in the measure point *O* and it is perpendicular on the constructive basic geometry plane *Oxy*;



FP – Main surface of tamping tine;
FS – secondary surface; β – sharp angle.

Fig. 16. The active part of the tamping tool.

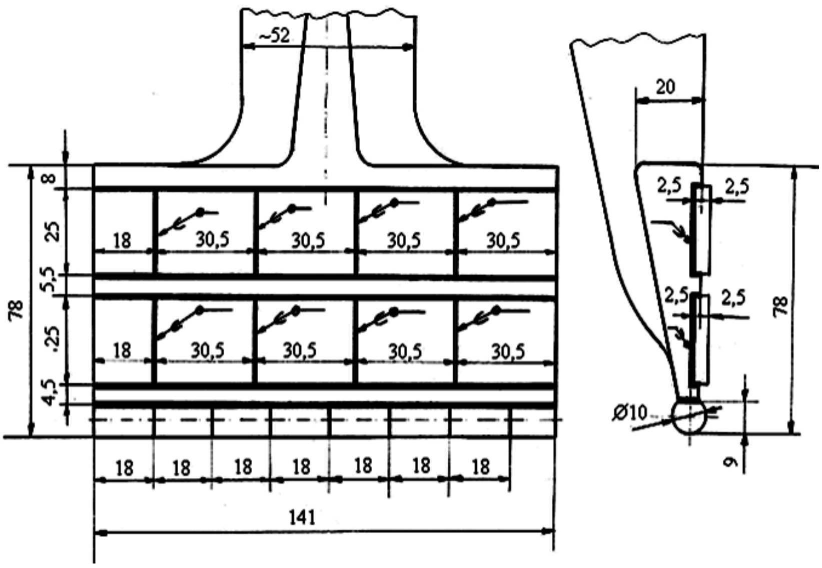


Fig. 13. Tine/blade covered with bodies from metallic carbides – version 1.

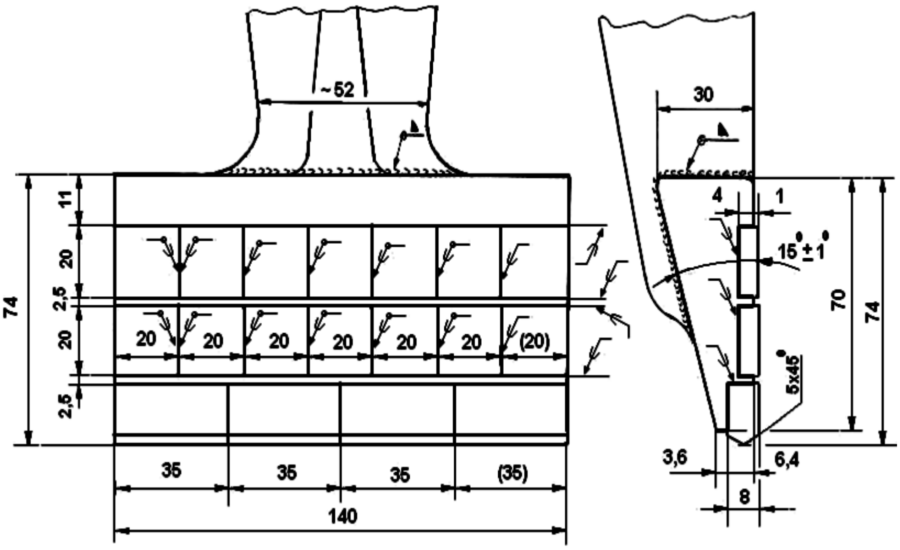


Fig. 14. Tine/blade covered with bodies from metallic carbides – version 2.

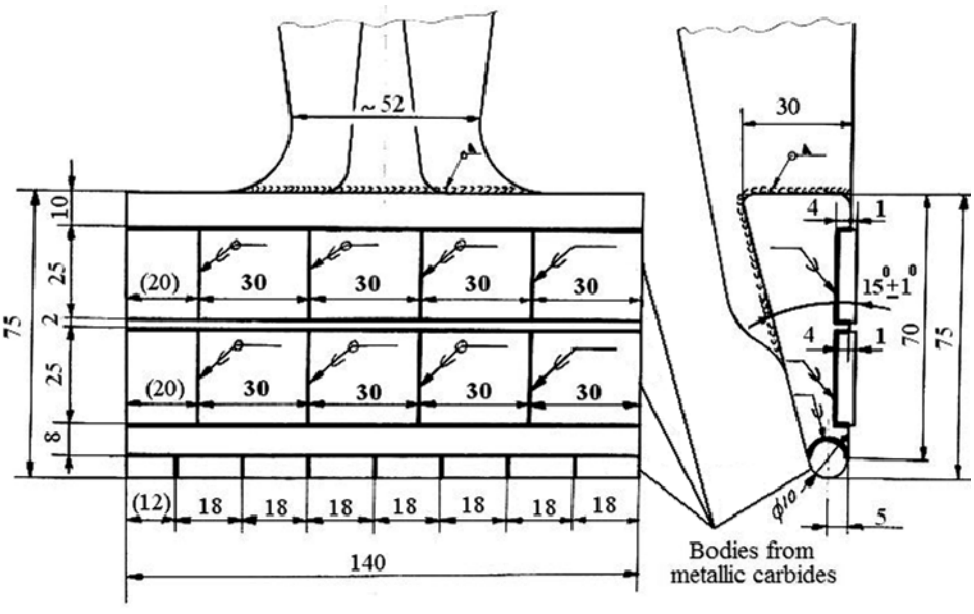


Fig. 15. Tine/blade covered with bodies from metallic carbides – version 3.

- The *constructive* measure geometry plane *Oyz*, which passes throw measure point *O* on the constructive edge geometry plane *Oxz*, and on the constructive basic geometry plane *Oxy* as well.

In the section *N-N* (Fig. 18), the geometry of active part of the tamping tools is described by the next constructive angles:

γ – the main surface angle,

β – the sharp angle of active part of the tamping tool,

α – the secondary surface angle (the secondary surface can *be* made from two surfaces with different inclination angles α and α_1),

δ – the "cutting" angle,

$$\delta = \alpha + \beta \;; \qquad (\delta_1 = \alpha_1 + \beta_1)\,; \qquad (1)$$

FP – the main surface of active part of the tamping tool,

FS – the secondary surface of active part of the tamping tool.

As in the cutting tools case, the relation is:

$$\alpha + \beta + \gamma = 90^0 \;; \qquad (\alpha_1 + \beta_1 + \gamma_1 = 90^0) \qquad (2)$$

λ – the inclination angle of the constructive edge.

On the *X-X* direction (Figs. 19 and 20), the geometric shape of active part of the tamping tools is described by the *K* angles of the lateral surfaces measured in compare-son with the constructive edge geometry plane *Oxz*.

The analyze and the study of the constructive geometry of active part of the tamping tools has a great importance regarding to discovering and designing of a new constructive geometry of these, for improving the quality of the tamping operation.

3.2. The functional geometry

The real angles which the tamping tool is working are angles that represent effective or functional angles; they are measured in comparison with the functional (real) rectangular reference system. This reference system is made of (Fig. 21):

- Oy_e – the axis that shows the penetration direction of the tamping tool into the ballast;
- Oz_e – the axis which is perpendicular on Oy_e and shows the effective tamping direction;
- Ox_e – the axis which is perpendicular on the axis Oy_e and Oz_e and which shows the positioning direction of the tamping tool (at the switch tamping machine);
- The functional basic geometry plane Ox_ey_e which passes throw measure point *O* from the active edge on which the geometry is measured, geometry plane that contains the penetration movement direction into the ballast Oy_e and it is perpendicular on the effective tamping direction Oz_e;
- The active edge functional plane Oz_ex_e which passes throw measure point *O*, contains the active edge or the tangent in measure point *O* and it is perpendicular on the penetration direction of the tamping tool into the ballast Oy_e;
- The functional measure plane Oy_ez_e which passes throw the measure point *O* and is perpendicular on the functional basic plane Ox_ey_e and on the functional active edge plane Oz_ex_e.

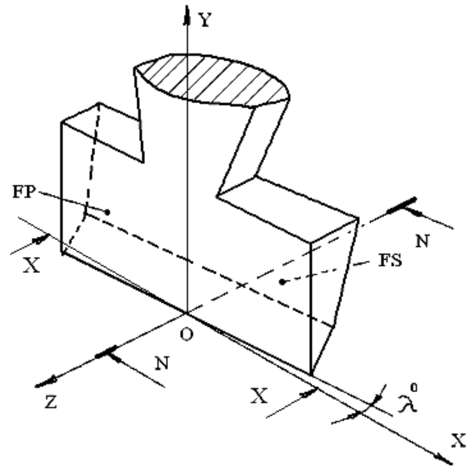


Fig. 17. The constructive reference system.

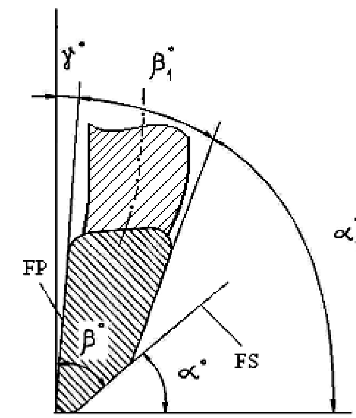


Fig. 18. The section (*N-N*).

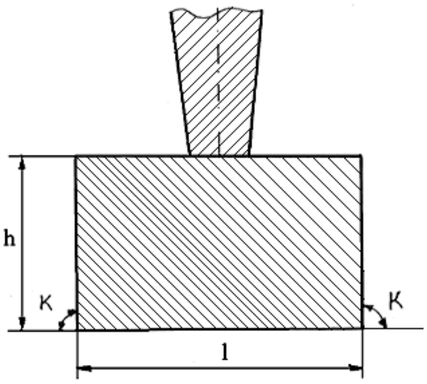


Fig. 19. The section (*X-X*) – variant 1.

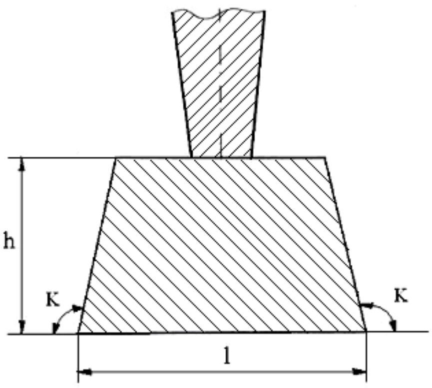


Fig. 20. The section (*X-X*) – variant 2.

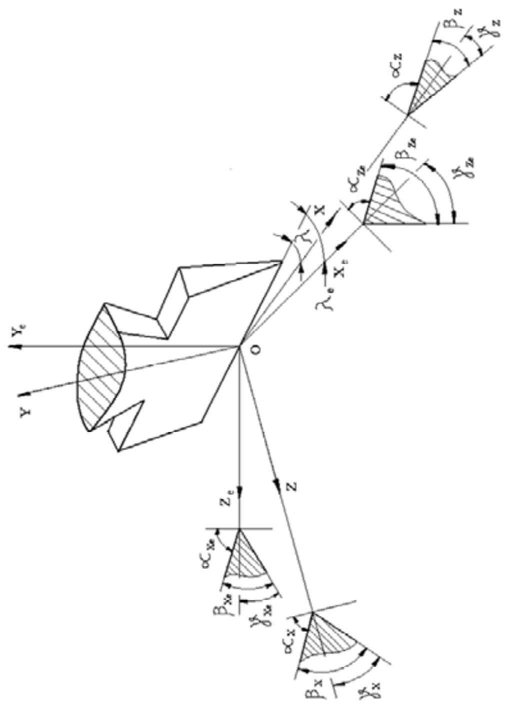


Fig. 21. The functional reference system.

The functional geometry of the tamping tools is a prerequisite regarding the definition of the real angles (effective or functional angles) which the tamping tools are working. This fact leads to the up gradation of the constructive geometry of the tamping tools with the main purpose of obtaining efficient tamping tools from the constructive point of view, to realize a high level quality of the tamping operation, to reduce the solicitations of the tamping tools and to increase the lastingness of those.

4. CONCLUSIONS

The analyze and the study of the functional and constructive geometry of active part of the tamping tools has a great importance regarding the discovery and the made-off of a new constructive geometry, which can help to obtain new tamping tools much better for their technologically qualities or on the other hand to obtain a new functional geometry, much better regarding the exploitation of the tamping tools and the quality of the tamping operation.

These new constructive geometries must guide in the end to increase the lastingness of the tamping tools and to reduce the construction, exploitation and reconditioning costs.

The researches of the tamping tool and particularly of the active part permitted the next accomplishments:

- finding the necessary conditions made by a tamping tool for realize the tamping operation;
- some elements and conditions that must be realized at the establishments of shapes and dimensions of the tamping tools;
- establishments of the constructive reference system necessary for construction, reconditioning and verifying the active part geometry of the tamping tools (constructive angles);
- establishments of the functional reference system which can define functional geometry (real angles which the tamping tools are working, angles that represents effective or functional angles);
- making a calculation method for the resistance forces that are opposite at the penetration of active part of the tamping tool into the ballast.

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Authors:

Eng. Sorin George Badea, Manager, S.C. Mechanized Maintenance of Railway S.A., Bucharest,
E-mail: soringeorgebadea@yahoo.com
PhD Eng., Cristinel Beşleagă, Chief, S.C. Mechanized Maintenance of Railway S.A., Bucharest, SIMC Buzău,
E-mail: cristibesleaga@yahoo.com
PhD Eng., Constantin Minciu, Prof., University "Politehnica" of Bucharest, Faculty of Engineering and Management of Technological Systems, Machines and Production Systems Department.
E-mail: minciu@imst.msp.pub.ro