STUDY OF THE DYNAMIC BEHAVIOR OF THE FRAME BETWEEN THE AXLES IN A VARIABLE-BASE TRACTOR

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Abstract. *This study focuses on analyzing the structural strength of the main frame in a variable-base tractor design, which serves an important function in cultivating rain-fed sloped lands to help reduce the adverse effects of water scarcity in Uzbekistan's agricultural sector. The research identifies potential loads and force directions that may arise during field operations, and the impact of these loads on the tractor's variable-base structure is simulated using SolidWorks software.*

Keywords: *variable-base tractor, front frame, additional loads, stress.*

Given Uzbekistan's strong dependence on agriculture, the advancement of efficient and sustainable farming methods is of critical importance. The construction of the Koshtepa Canal in neighboring Afghanistan presents a serious challenge, as it is expected to decrease Uzbekistan's annual water availability for agriculture by approximately 15%. This situation underscores the urgent need for innovative approaches that minimize reliance on water resources.

One potential solution is Controlled Traffic Farming (CTF), a modern agricultural system designed to optimize field operations and reduce soil compaction. However, effective implementation of CTF requires significant modifications to tractors particularly to their front axles and wheelbases to suit the specific configurations demanded by this technique. Although variable-base tractors are already in use in Uzbekistan, their operational efficiency remains limited, as adjusting their wheelbase involves substantial manual effort and technical expertise.

Consequently, advancements in tractor design and technology are essential to facilitate the wider adoption of CTF and to promote sustainable, high-efficiency agriculture in Uzbekistan. At the current stage of wheel tractor design and development, innovations that improve performance are seen as the most promising directions especially those that reduce anthropogenic impacts, increase safety, enhance maneuverability, stability, and overall ride smoothness. Modifying the wheelbase of four-wheel tractors plays a key role in achieving these goals. Previous research has demonstrated that optimizing the wheelbase significantly improves both static and dynamic stability, thereby contributing to better traction, control, and overall operational effectiveness.

The TTZ-80.10 universal hoeing tractor is a product manufactured by the Tashkent Tractor Plant (Tashkent Traktor Zavodi, TTZ). The factory was originally founded in 1942, initially producing ammunition. Later, in 1997, the joint venture "Uzbekkeystractor" was established, marking a collaboration between the Tashkent Tractor Plant and the American company "Keys."

At present, low-clearance four-wheel tractors of the TTZ-80.10 type are widely utilized across the Republic of Uzbekistan, both for transportation purposes and for various agricultural operations, particularly in mountainous and sub-mountainous regions [1].

This section explores the concept of variable-base tractors, analyzing their benefits and drawbacks. The findings reveal that designing a variable-base mechanism is relatively complex. In the universal hoeing tractors currently used in Uzbekistan, simplified constructions are generally employed to modify the wheelbase. Specifically, the wheelbase adjustment in these tractors is achieved by altering the front axle structure.

1. The adjustment of the tractor's wheelbase is performed by changing the angle of the G-shaped front axle arm. The mechanism consists of a portal-type spring-mounted pivoting axle, variable-track steerable wheels, a tubular steel beam, and a front axle connected to the semi-frame axle through a hinged joint

2. Changing the tractor base in this way is also done by changing the front part of the tractor (Figure 1)

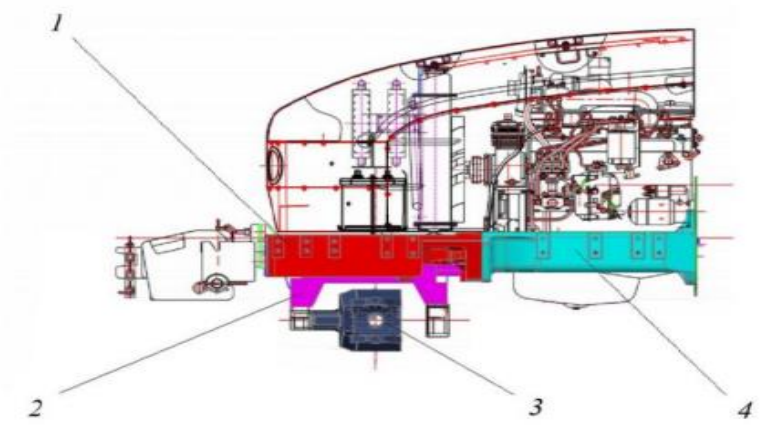


Figure 1. Tractor front: 1-front beam; 2-bracket; 3-front hammer; 4-spars.

In the proposed design, the front axle clearance of the tractor is regulated by an adjusting screw installed inside the front axle elbow. This mechanism allows the height of the semi-axle agro-technical slot beneath the gearbox to be varied within a range of 780 mm to 870 mm. The rear axle clearance is modified based on the position of the outboard gear, which can be set in two configurations. To achieve a vertical alignment, the outboard gear is rotated rearward at an angle of approximately 58–60° from the

vertical position. By rotating the onboard reducer through this angle, both the ground clearance and the wheelbase length of the tractor are adjusted accordingly. As discussed earlier, each existing base conversion mechanism possesses distinct advantages and disadvantages. Considering these factors, this study proposes a new structural design a different type of variable-base mechanism aimed at improving functionality and efficiency.

In the proposed design, hydraulic cylinders serve as the primary components responsible for adjusting the tractor's wheelbase. Based on the frontal frame dimensions of the TTZ-80.10 tractor and the specifications of the hydraulic cylinders, an initial mechanical layout of the new system was developed (Figure 2).

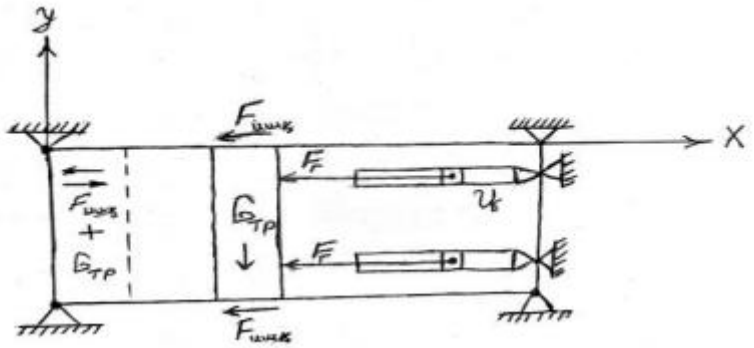


Figure 2. Calculation scheme.

The required power output for the hydraulic cylinder was calculated. Based on the schematic representation shown in Figure 3, the force equation can be expressed as follows:

F1>F2

When evaluating the load acting on the modified front axle, it's also important to consider how the tractor's weight is distributed between the front and rear wheels. According to guidelines developed by the Canadian Department of Agriculture and Rural Development, the way weight is shared between the two axles depends mainly on the tractor's design, especially its drive type.

By this determined extra loading force quantities we have analyzed stresses of the tractor's front axle and base frame which may occur on the real farming fields. For this we used SolidWorks software program as mentioned in previous chapter.

Conclusion

By utilizing a variable base mechanism, we have significantly enhanced the versatility of the universal mowing tractor. This means it can now be used not only in mountainous and foothill regions but also in other areas where specialized tractors are typically required, thereby expanding its application range compared to other conventional tractors. We have developed and established parameters for a variable base mechanism for a universal mowing tractor, resulting in a design that is more versatile, stable, and maneuverable than other universal mowing tractors. We believe

that we have created a universal mowing tractor with a variable base that is both specialized and universal, offering increased stability and maneuverability, making it suitable for both mountainous and foothill regions as well as other conditions. As we mentioned above, new modified base mechanism also has disadvantages too it is one of the main issues to ensure the cleanliness of the rail surface of the moving part, which is one of the main parts in the base change, because when moving in the field and plowing the field, dust and other polluting elements are raised from the ground.

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