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# DESIGN AND MANUFACTURING A NEW PLATFORM FOR RAPESEED HARVESTING IN IRAN

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**ABSTRACT** The JD955 series combine which is a conventional combine in Iran does most of the combine harvesting of rapeseed. Because of shape and condition of rapeseed, harvesting losses were very high. This project was done in order to solve that problem. It was made by minimum changes in mechanisms of the JD955 platform and it attached to the platform. Studies were about hydraulic system, stability and exact analysis of power train of blade. The main aspect of design was using new power train of blade. In that case Working Model 3D, SolidWorks 3D CAD Design and NISAII softwares were used. Complementary designs were investigated; checking of chassis firmness and introducing a new method for drive mechanisms for the blade. Using NISA II and a finite element method indicated that the platform chassis was not firm enough and needed some changes in its structure. Static analysis showed that maximum Von Mises stress concentration was 311 MPa. It was reduced to 159 MPa by reinforcement of the chassis. Deflection analysis showed that maximum blade deflection was 12 mm. The new blade was 920 mm in front of the old blade and derived by a 1710 mm rod which was added to the drive mechanism. Natural frequency of rod and transmission motion frequency ratio was 2.65 which satisfied safer operation conditions. Field tests determined that working speed and surface capacity of the combine were improved when using the new platform. It reduces harvesting losses.

**Keywords:** JD 955, Design, Rapeseed, Harvesting, Platform, Finite Element Analysis.

**INTRODUCTION** Today by increasing of world's population and more needed to food processing caused to more attention to the modern technologies especially in agricultural machineries. In this case oil seed and specially rapeseed as one of the main source of foods were observed. It belongs to the *Crucifera* family and in normal condition it is annual plant. The main products of rapeseed are oil and cake and mainly it can find as industrial and edible form (Pekrunsun et al., 1995). Rapeseed was harvested in Iran by conventional combines by doing needed adjustment and technical notes till 1997. On the other hand the general form of natural rapeseed because of its sensivity caused exceeding losses when it dose harvest. Based on Halilun et al. (1996) the main reason of losses was high tension to the tubes of seeds and falling done on the land during harvest by conventional combines. It seems that it was necessary to do a few changes in old shape of JD955 platform as the main type of harvester in Iran. It leads to increase its capability during rapeseed harvesting. This research was done by research and development (R&D) department of Iran combine manufacturing company (ICMCo.).

**MATERIALS AND METHODS** Two main type of special rapeseed platform as flexible and attachable were considered. Considering a few criteria in JD955 ended up to selecting attachable platform as based model. The first step was choosing an initial model consist of main frame, side walls, horizontal and vertical blades which can easily attached to the based platform. Dimension and weight of initial model were select selected by reel operation, hydraulic system capability and balancing of machine characteristics (fig.1). New horizontal cutter bar was located 920 mm in front of based platform blade which was powered by long pitman. A long and whole pitman by 1710 mm length was used to transfer required power to the new cutter bar.

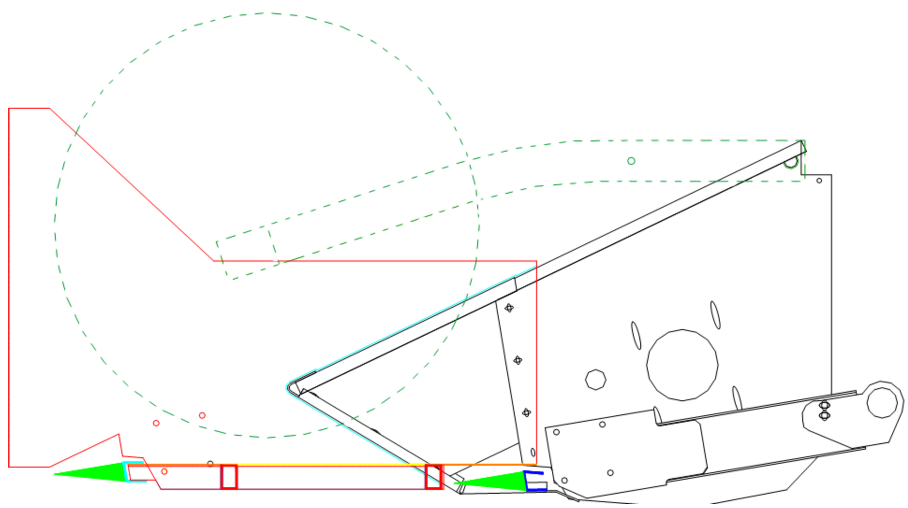

Figure 1. Primary model of rapeseed harvest platform

Working Model 3D and SolidWorks 3D CAD Design softwares were used to assembling and dynamic analysis of initial model. In complementary design process based on shape, material and other properties of pitman its deflection, buckling and natural frequency of mechanism were check. NISAII was used in finite element analysis in order to displacement and stress analysis investigations as a new method of agricultural machinery design (Lemy, 1998) and (Romanson et al., 1997)

**Finite element analysis of platform** Totalling 5275 elements which created in 3D a mass in the shape of a quadrilateral element with four nodes as plate and linear element with two nodes as beam were used to making model. Displacement and stress analysis (fig. 2, 3) showed that more welded is needed in main frame to achieve adequate strength of chassis.

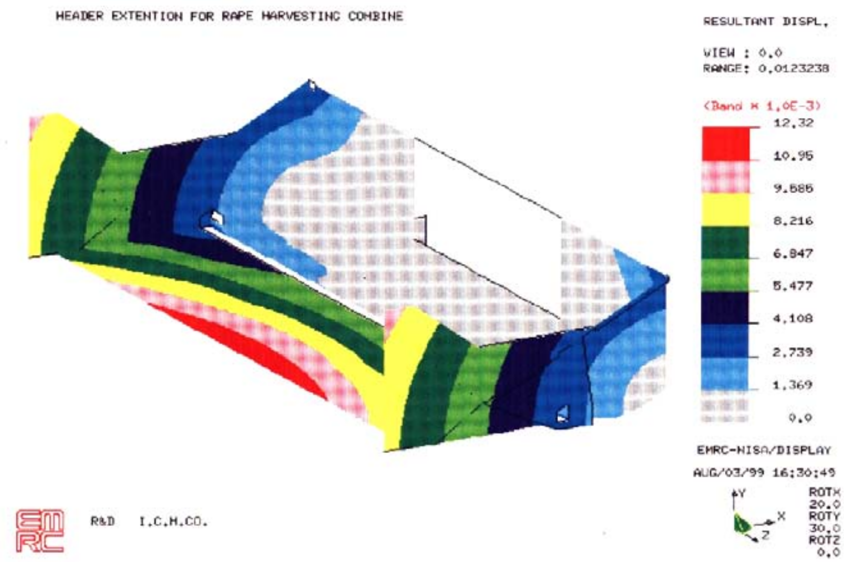


Figure 2. Displacement analysis of the reinforced platform

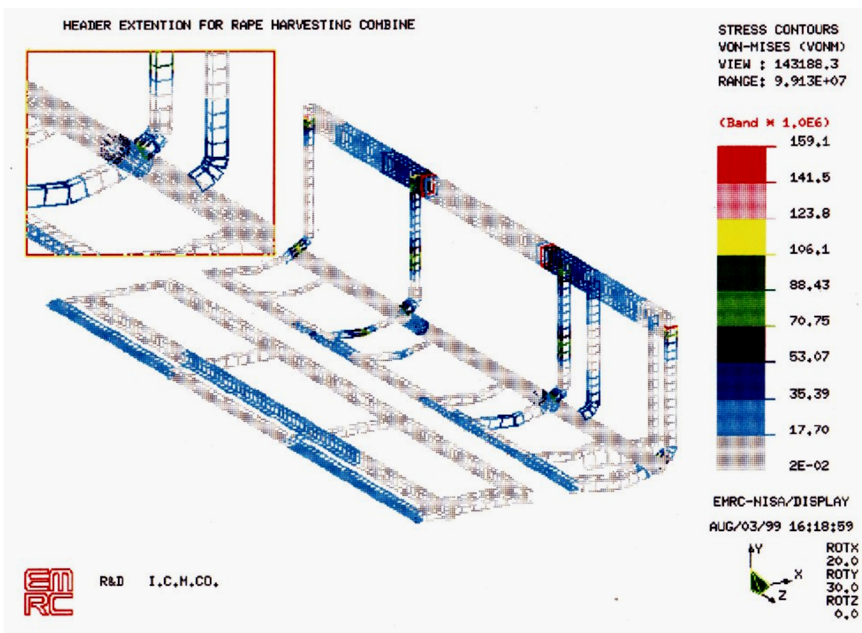


Figure 3. Stress analysis of reinforced chassis of the combined platforms

**Cutter bar analysis** The forces P resisting knife movement in the sum of all the forces acting on the knife

$$P = P_{avg} + P_j + F \qquad (1)$$

Where Pavg is the average resistance force on cutter bar, Pj is the inertia force of the knife and F is the frictional force (Popove and Klenin, 1987). Assuming the resistance to cutting is constant and proportional to the load area F1, the coefficient ε which refer to the number of plant per cm2 and in this case $2 \leq \varepsilon \leq 3$ and the number of cutter Z, following expression can be used to determine the average force resisting cutting of stalk in a standard single stroke cutter;

$$P_{av} = \frac{\varepsilon F_1 Z}{X_C} \tag{2}$$

The maximum inertia force is governed by the m_k of the knife …

$$P_j = m_k J_K \tag{3}$$

To determine friction force acting on the knife two forces F1 and F2 were considered which are friction forces due to the weight of knife and friction force due to connecting rod respectively;

$$F = F_1 + F_2 \tag{4}$$

$$F_1 = G_K f \tag{5}$$

$$F_2 = \left[ \frac{\left(P_{av} + P_j + F_1\right)\tan\beta}{1 - f\tan\beta} \right] f \tag{6}$$

Where $G_k$ is the weight of the knife, f is the coefficient of friction and β is the angle of pitman. The power requirement to overcome the require forces of resistance to the knife motion is obtain by,

$$A = \frac{Pv}{1000} \tag{7}$$

where v is the knife speed.

**CONCLUSION** Results of finite element analysis showed that no uniform stress distribution was happen. Maximum stress concentration based on Von Misses theory was done at feeder house and chassis of platform connection by 311 Mpa. . It was necessary to improve strength of that region. After that it was reduce to 159 Mpa. Maximum deflection of platform was 12 mm in the middle of blade.

Dynamic analysis of new power train to the blade showed that linear speed and stroke of blade are 1.9 m/s and 76 mm respectively. Natural frequency of rod and transmission motion frequency ratio was calculated 2.65 which made safe operation condition.

About cutter bar analyses it found that resistance force of knife and power requirement were 4.34 kN and 6.53 kW respectively. Power requirement was extremely 8% total of engine power.

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