SOLIDWORKS 3D PARAMETRIC MODELLING TECHNIQUE FOR ROOT CUTTING EQUIPMENT DECLINING GROWTH OF SHOOTS IN ORCHARDS

MARINELA MATEESCU¹, EUGEN MARIN¹, VALENTIN VLĂDUȚ¹, DRAGOȘ MANEA¹, GABRIEL GHEORGHE¹, PETRU CÂRDEI¹, ALEXANDRU TUDOR², SORIN BORUZ², ION SĂRĂCIN², FLORIN STOIAN²

¹/National Institute of Research-Development for Machines and Installations Designed to Agriculture and Food Industry – INMA Bucharest, Romania ²/University of Craiova, Faculty of Agriculture, Craiova, Romania

Keywords: knife disc, root cuttings, CAD, FEA structural analysis

ABSTRACT

This work was focused, by using computer aided engineering application (SolidWorks) and structural simulation (SolidWorks SIMULATION), on obtaining a technical and economic strength indicator used in the analysis of metallic material choice from which is made active body large diameter disc knife type, that equips the technical equipment for soil tillage on trees row, while cuttings root for moderating growth of shoots and precision foliar fertilization. For this purpose, on the 3D parametric modeling were selected from the software library various metallic materials, followed by finite element analysis (FEA) which was carried out to simulate the distributions of stress and strain on the body active. Based on the resulting data, were determined the reports price / coefficient of resistance for the materials analyzed. Comparing these indicators led to the selection of a material that has high resistance under a price as low as possible. Analysis based on technical and economic choice of a metallic material reduces the time validation of the design, by eliminating the realization and physical testing, and allows management to determine the existing resources in the company in order to use their total for achieve economic and financial results as high.

INTRODUCTION

Development of computer hardware and software specialized technology computer aided design (CAD) and structural analysis (FEM) enables design engineers to solve complicated problems in the field of agricultural machinery, using and numerical methods in a virtual way without realizing physical manufacturing and laboratory-field testing. [4]

In December 1993, SolidWorks founder Jon Hirschtick, has appointed a team of engineers to design a 3D CAD technology more accessible. They have managed to create the first 3D CAD software capable of operating on a Windows platform to run that technology was not need expensive hardware and software systems. The first version of SolidWorks software was launched in 1995. DassaultSystèmes acquired the company in 1997. Currently, DassaultSystèmes SolidWorks Corp. offers a complete toolkit to create, simulate, publish and manage data, optimizing innovation and increase productivity engineering resources. All these solutions work together to enable companies to design products in a faster, more efficient and better. Continuing to implement its motto of "ease of use" company DS SolidWorks Corp. has created new product extensions, including SolidWorks SIMULATION that allows each engineer to perform simulation structural parts and assemblies using finite element analysis (FEA), to improve, to validate the performance and reduce the need to build costly prototypes. Design engineers primarily use simulation to determine the structural strength and stiffness of a product by comparing the stress and deformation of the components. [5]

Optimal design for the development of farm machinery for mechanized systems maintenance in horticulture is linked directly or indirectly properties of metallic materials constituting the active bodies.

In practice, the choice of metallic materials (metals and alloys) requires a technical analysis, and economic, structural performance and mechanical properties of failing to ensure their widespread use.

It is therefore very important to find a technical and economic strength indicator to be used in the analysis based on technical and economic choice of metallic materials used in construction machinery.

Analysis of resistance and rigidity of the active body through structural analysis method is an alternative easy and simple to interpret quality technical equipment. [1]

Resistance criteria are known to be taken into account by designer's specialists, namely:

- Wear resistance;

- Resistance to damage by shock or a very large force.

In practice, because it takes time, wear resistance is very difficult to determine, it is important in the selection of the material (and possibly shape).

In this context, the paper presents research conducted using finite element analysis (FEA) to determine tension and deformation taking into account the action of a large external forces.

They were made for different metallic materials from which it is possible to achieve knife disc from technical equipment to work the soil in the row of fruit trees, along with cuttings root for moderating the growth of shoots and foliar fertilization precision that was designed to INMA Bucharest.

Based on the data obtained were calculated resistance coefficients and determining the reports price / coefficient of resistance for those materials has resulted in a technical and economic indicators of resistance that can be used in the analysis based on technical and economic choice of a material metal, to reduce design validation time by eliminating achievement and physical testing and obtaining economic and financial results as possible.

MATERIAL AND METHOD

Technical equipment for soil cultivation row of fruit trees, root cuttings while moderating the growth of shoots and precision foliar fertilization (fig. 1), is intended to execute following works:

- plowing a strip at a distance from the trunk to maintain a loose soil surface;

- root pruning at a distance from the trunk to preserve trees and maintaining low waist root growth within the nutrition space of each tree;

- precision foliar fertilization.

The technical equipment comprises an active organ type disc knife of large diameter, which is rigidly mounted on a metal frame via a support provided with a guide articulated and means of regulating the working depth and lock the cutting direction vertical. [2]

Pushing it into the soil is achieved due to equipment mass that can be adjusted by adding additional mass mounted on the frame for obtaining a suitable working depth. Because it penetrates lis edge profile and cut slightly into the soil to a depth adequate root system and a precise distance from the trunk.



Figure 1.Technical equipment for soil cultivation row of fruit trees, root cuttings while moderating the growth of shoots and precision foliar fertilization

Disc cutter diameter D (fig. 2, a) is given by equation (1):

$$D = 2(a + d_a + \frac{a}{2} + d_{a1}), mm$$
(1)

where: a is the working depth, in mm (a=260 mm);

d - flange disc diameter (d = 0,25D);

 d_a =15 mm; d_{a1} =25 mm, from safe operating conditions.

From the analysis of similar construction, large diameter disc blade diameter varies between 800 ... 900 mm. Disc thickness of 5 ... 6 mm and sharpening angle of 15 ... 30 °. The angle α formed by the force R to the horizontal is 45 ... 55°.



Figure 2. Active body type large diameter disc knife

During work, R force acts on the disc - the resultant of the elemental cutting forces (fig. 2, *b*).

$$\bar{R} = \overline{R_X} + \overline{R_Y} \tag{2}$$

 R_x resistance opposed to disc movement is:

$$R_X = K \times a_1 \tag{3}$$

where:

K is the resistance per meter working width specified in disking with heavy disc harrow; K = 4000...8000 N/m [6];

 $a_1 = a + d_a = 260$ mm.

For the analysis based on technical and economic choice of metallic material of construction body active type knife disc of large diameter fitted to the machinery for soil tillage row of trees, while cuttings root for moderating the growth of shoots and foliar fertilization of accuracy, the following steps were carried out:

- finite element analysis (FEA) by using the simulation structural SOLIDWORKS SIMULATION, which involved importing the geometry achieved with the application of Computer Aided Engineering (SolidWorks), defining material, defining appropriate restrictions meshing, calculation analysis to determine tensions under the effect of loads applied and viewing results; [3]

- determination of price reports / coefficient of resistance for those materials in the library software;

- choice of material showing high resistance in terms of a price as low as possible.

RESULTS AND DISCUSSIONS

The first step in using finite element analysis consisted in building the model (3D) for large diameter disc knife. Figure 3 presents an axonometric isometric view of the CAD model created with the Solidworks 2013. The input data for FEA analysis were as follows:

- outer diameter: D = 800 mm;

- disc flange diameter: d = 200 mm;

- large disk thickness: g = 6 mm

- angle α formed by the force R with horizontal: $\alpha = 50^{\circ}$;

- resultant of the cutting elementary forces (after all calculations): R = 3000 N.



Figure 3. Axonometric isometric CAD model view of large diameter disc cutter

Static analysis involved:

- selection options as static type analysis, solid meshing and solver for the type of FFEPlus (fig. 4);

Analele Universității din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series)Vol. XLVI 2016

itudy Details	
Study name	Study 1 (-Default-)
Analysis type	Static
Mesh type	Solid Mesh
Thermal Effect	Include temperature loads
Zero strain temperature	298Kelvin
Solver Type	FFEPlus
Inplane Effect	Off
Soft Spring	Off
Inertial Relief	Off
Friction	Off
Use Adaptive Method	Off

Figure 4. Selection options as static type analysis, solid meshing and solver for the type of FFEPlus

- the selection of some materials from SolidWorks 2013 library and automatically assigning these properties (Table 1) defining characteristics of the material (fig. 5);

Stanless Steel Sheet (55) A Properties	Tables & Curves App	earance 0	rossHatch Custom App	plication Data f * *	1 3 _ ters carbons						
Annealed Staniess Steel (35) Material p	Material properties			§Ξ 201 Armealed S	tainless Steel (SS)	Material properties	s				
Annealed Stanless Steel (SS) Material	Materials in the default library can not be edited. You must first copy the material to			the material to	-3∃ A286 Iron Base	Superality	Materials in the o	default library ca	n not be	e edited. You must first copy the	material tr
0 Steel, annealed at 865C a custor	milbrary to edit it.				AIST 1010 Stee	, hot rolled bar	a custom library	to edit it.			
8 Steel, normalized at 870C	Long March				-\$∃ AISI 1015 Stee	, Cold Drawn (SS)	and the second s	-			
0 Steel, annealed Picce 1	Linear Elas	ac isotropic	Ŷ				Model Type:	Linear Eleste	: Isotrog	pic v	
0 Steel, normalized Units:	SI - N/mm*	2 (MPa)	÷		SE AISI 1020 Stee	l, Cold Rolled	Links	SI - N/mm*2	(MPa)	*	
e 316L staniess steel	Ctual				-§Ξ AISI 1035 Stee	(55)	Colonia	(Teal)			
A2 Tool Steel	a provide a second a				AIST 1045 Stee	l, cold drawn	CREATENCY.	34661			
Name	Plain Carbo	in Steel			-\$Ξ AESI 304		Name:	Cast Carbon	Steel		
Defeat	feitre in .				홍프 AISI 316 Anner	ied Stainless Steel Bar (SS	Debuttfaker	100000000000000000000000000000000000000			
ateks	Plax von M	ises Stress			SE AUST 316 Stairs	ess Steel Sheet (SS)	criber (crit	Max yon Mis	es Stres	95	
Descho	Cices				SE AIST 321 Annei	ied Stainless Steel (SS)	Description:				
					AISI 347 Annes	ied Stainless Steel (SS)					
 Source: 					-\$E AISI 4130 Stee	, annealed at 865C	Source:				
5.14	chitos Defined				SE AISI 4130 Stee	, normalized at 870C	Surapublity	Defined			
	(Alexandream)				SE AUST 4340 Stee	, annealed					
Departu		Table .	Ittelle		₹E AIST 4340 Stee	, normalized	Departs	L.		links	
Property	which on the W	210000	Units Allowed D		AISI Type 3164	stainiess steel	Clashe Modulus	20	0000	N/mm ³ /2	_
Electronic Mo	Ration in XV	8 28	RUA		SE ALSI Type A2 T	ool Steel	Poissons Farm	0	32	N/A	
Share More	dulus in XY	79000	Nimm*2		- § E Alloy Steel		Shear Modulus	76	000	N/mm*2	
Mass Den	1577	7500	kom/3		SE Alloy Steel (SS)		Denaity	78	00	kg/m*3	
Tensle St	trength in X	399.83	N/mm*2		STM A36 Stee	0	Tensile Strength	40	2.55	N/mm*2	
Compress	sive Strength in X		Nimm*2			0	Compressive Stren	igth in X		N/mm*2	
Yield Street	mgth	220.59	N/mm*2		E Cast Carbon	steel	Yield Strength	24	8.17	N/mm*2	
Thermal E	expansion Coefficient in	X 1.3e-005	5 /K		§≣ Cast Starless :	iteel	Thermal Expansion	Coefficient 13	20-005	K	
Thermal C	Conductivity in X	43	WI(m K)		§∃ Chrome Stainle	is Steel	Thermal Conductive	ty 30		YO(m-K)	
Specific H	ieat	440	J/(kg-K)		1.3 = Galvaniand Ster	4	Specific Heat	50	10	J/(Kg-K)	
and the second se	a second a second as				a set of the set of th						
Als V	Apply Close	Seve Steel Sheet Stainless S e Superallo el, hot rolle el, Cold Dra	LUA Config Help (SS) ^ Heel (SS) // // // awn (SS)	Properties Tables & Material properties Materials in the d a custom library f	A Curves Appearance A Curves Appearance a fault library can not to edit it.	el CrossHatch Questom	Application Data [F.*]	Cose .	Sav	re Configue Help	
M	Apply Close ###201 Close ## 2023 Centorn ## 2023 Centorn ## 2024 Annealed ## 2024 Annealed ## 2025 Lone Bad ## 2021 Lone Bad ## 2021 Lone Bad ## 2021 Lone Bad ## 2021 Lone Sat ## 2	Seve Steel Sheet Starriess S el, Saprarilo el, Cold Rol el, Cold Rol el, Cold Rol el, Cold Rol el, Cold Rol el, Cold Rol el, Cold dra haied Starriv elses Steel S saied Starriv el, armeale	IssA Config (DS) (CS)	Material properties Material properties Materials and the second Materials and the second Material Second Material Material Second Material Second Mate	A Curves Appearance A	ed CrossHeith Queton be edited. You must first o oppe v) v	Application Data <u>F</u> . *	Cose	Sav	re Config Hep	
> V (Apply Close ## 1023 Carbon # 2023 Carbon # 2023 Carbon # 2023 Carbon # 2023 Carbon # 2024 Annealed # 2025 Carbon # 2024 Annealed # 2025 Carbon #	Seve Steel Sheet Stamless S e Superailo el, hot rolle el, Cold Dra el, Cold Dra el, Cold Dra el, Cold dra raied Stami el, son el Steel S soled Stami el, armeale el, normala el, normala	IssA Config. Help (SS) (SS) A of bar axen (SS) Bed axen (SS) Bed axen (SS) Bed axen (SS) axen (SS) axen (SS) axen (SS) axen (SS) axen (SS) bar bar (SS) axen (SS) bar bar (SS) bar (SS) bar bar (SS) bar	Properties Tables 8 Material properties Material properties Material in the d a custom Broary I Middle Types Units Category Tame: Category Tame: Category Tame: Category Category Source Source Source	Curves Appearance Convest Appearance Convest Appearance Convest Appearance Convest Income ConvestIncome Convest Inconvest Income C	et CrossHatch Dustom be edited. You must first o oppic v) v	Application Data (F. e.)	Close	Sav	e Config Help	
> [Apply Close # pipy Close # 2012 Carbon Close # 2012 Annealed Acade Dun Bas # ASTE 1010 State Fill Acade Dun Bas # ASTE 1010 State Fill Acade Dun Bas # ASTE 1010 State Fill Acade Dun Bas # ASTE 1015 State Fill Acade Dun Bas # ASTE 1000 State Fill Acade State # ASTE 4000 State Fil	Seve Steel Sheet Stanless S e Superalio el, Cold Dra el, Cold Dra el, Cold Rol el (SS) el, cold dra naied Stanli less Steel S saled Stanli el, armeale el, armeale el, armeale el, armeale	IssA Config	Troperties Tables 6 Material properties Materials in the d a custom Brary I Modul Type: Undu: Undu: Undu: Category Category Category Category Category Source: Source: Source: Source: Source: Property	A Curves Appearance A Curves Appearance A Curves Appearance Sector Statement Curves Elestic fact Curves	el CrossHatch Dustom be edited. You must first o nppc v) v ess v	Application Data F apply the meterial to	Close	Sav	re Config Hep	
> Theorem	Approx Close ####### Close ####################################	Seve Steel Sheet Stamless S e Superailo el, hot role el, Cold Rol el (SS) el, cold dra haled Staml el, anneale el, anneale el, anneale el, anneale el, anneale	IssA Config (DS) (SS) (Properties Properties Properties Product Types Units Category: Tome: Cefrait felare offerrore Despiderr Source Soutembility Property Prop	A Curves Appearance Sector Appe	ed CrossHatch Dustom be edited. You must first o oppic v) v ess v	Application Data R +	Close	Sav	re Config Hep	
> V	Apply Close 4 pply Close 2012 Carbon Close 2012 Carbon Close 2012 Carbon Close 2014 Annealed Addit John Bat 4 Atti John Bat Addit John Bat 4	Steel Sheet Starriess S e Superailo el, hot rolle el, Cold Rol el (CSS) el, cold dra naied Staini less Steel S asied Staini el, armoale el, armoale el, normaliz El, normaliz El, normaliz El, normaliz	Issa Config (BS) (BS) (CS) (Bd)	Troperties Tables 8 Materials roperties Materials roperties Materials roperties Units: Units: Units: Category: None: Category: None: Cereptident: Source: Source: Source: Source: Material: Property Eletet Modulas Proseers Ratio	A Curves Appearance A Curves Appearance A Curves Appearance Section 1	et CrossHatch Quatom be edited. You must first o oppic v etcs v Units Nome*2 Nock	Application Data F. et a	Cone	Sav	e Config Hep	
→ Interstit	Appendix Close 4pply Close 3 2032 Gerboon 3 2032 Gerboon 3 2014 Annealed 3 2015 Interset 3 2015 Inter	Store Steel Sheet Starriess S is Superailo el, Cold Rol el, Starrielos Tool Steel Col	IssA Config (DS) (CS) (Properties Tables & Properties Tables & Protect of a custom locary to Produit Type: Units: Category: Reme: Cetruit Felare cohorco: Derostborn Source Sustainability: Property Ensiste Modulant Present Modulant	A Curves Appearance Section Sector Se	edited. You must first o poper v) v Umits Norme*2 Norme*2	Application Data R +	Core .	Sav	re Config Hep	
	Apply Close # pip/ Close # 2012 Carbons Close # 2014 Annealed Ad365 forn East # Al51 1010 55% Al311 1010 5% # Al51 1010 5% Al311 1010 5% # Al311 316 Ann Al311 316 Ann # Al311 4100 5% Al311 4100 5%	Steel Sheet Stanless S e Superailo el, hot rollo el, cold Dro el, cold dra el cold dra el cold dra maied Stanli less Steel S saled Stanli el, anneale el, normala el, anneale el, anneale el, anneale el, anneale el, anneale	Inva Config		Curves Appearance Appearance Curves Appearance Curves Control Curves Curve	et CrossHatch Custom be edited. You must first of oppic v 0 v ets v Sinks Nemr'2 Nonr'2 Nonr'2 Nonr'2	Application Data F. e.	Core .	Sav	e Config Hep	
	Appply Close ###201 Close ## 2023 Celose # 2023 Celose # 2021 Alsti 1020 # 2021 Alsti	Store Steel Sheet Starries S Starries S e Super allo el, hot rolle el, Cold Rol el (SS) el, cold dra maied Starri less Steel Starries el comada el, anneale el, normala el, anneale el, normala t. starriesa Tool Steel	IssA Config (DS) Area (DS) Area (DS)	Properties Tables & Properties Tables & Protect of cogeneties Product Types Units: Cetropary: Tome: Cetrosit Follow: Cetrosity Property Ensity Monaulus Development Source Transes Stereough	A Curves Appearance of the second sec	el CrossHetch Dustom be edited. You must first o nppic v) v ess v Umts Notes	Application Data R +	Core .	Sav	re Config Hep	
> [Apply Close # 2012 Carbon Close # 2012 Carbon Close # 2014 Annealed Add6 Une hand # Alst 1010 Size Alst 1010 Size # Alst 1010 Size	Steel Sheet Stantes S e Superalto e Superalto e, Cold Rot el, Cold Rot el, Cold Rot el, Cold Rot el (SS) el, cold d'a el (SS) el, amolé el stantes ta	Inva Config		A Gurves Appearance Appea	et CrossHatch Custom be edited. You must first of oppic v 0 v ets v Units Nonm*2 NoA Nome*2 Note*2 Note*2	Application Data F. e.	Core .	Sav	e Config Hep	
> Theorem	Appply Close ###### Close ## 2023 Cerboon ## 2023 Cerboon ## 2023 Cerboon ## 2021 Cerboon	Sante Steel Sheet Stantes S expendio el, hot rolle el, cold rol el, cold rol el, cold rol el, cold dia el, cold dia el, arrada el, arrada el, arrada el, arrada el, arrada el, arrada el, arrada el, arrada el el el el tatol	IssA Config (SS) Action (SS) P (blar sea Statel Bar (SS) eas Statel Bar (SS) eas Statel (SS) eas	Properties Tables & Material properties Material properties Material properties Material properties Material properties Cells of Tables Cells	A Curves Appearance Stell Curves Elestic test Stell Aley Steel Aley Steel Aley Steel Defined Value 210000 7008 708 7	el CrossHelth Dustom be edited. You must first o oppic v) v ess Units Nome*2 Nome*2 Nome*2 Nome*2	Application Data <u>F</u> .*	Core .	Sav	re Config Hep	(
	Apply Close # 2013 Cerborn # 2013 Cerborn # 2014 Annealed # 2015 Status #	Some Stanles Stanles S Stanles S expension et, Cold Orro et, Cold Orro e	Inva Config	Properties Takes 8 Materials and properties Materials and properties Materials and the second properties Under Under Category Teame: Category Teame: Category Teame: Category Teame: Source Source Source Source Source Source Source Property Proper	Corricient 1.2-00	et CrossHetch Custom be edited. You must first of oppic v 0) v ets v Umits Not Not Not Not Not Not Not Not Not Not	Application Data F + 1	Core .	Sav	e Config Hep	
	Apply Close ###### Close ###### Close ####################################	Sante Steel Sheet Stanites S expendio e, hot role e, cald for e, cald for e, cald for e, cald for e, cald for e, call for e, annede e, normalia e, annede e, normalia i, stanies teel steel steel steel steel steel steel steel steel steel steel steel	IssA Config (SS) (Properties Tables & Material properties Material properties Materials in the d a custom locary i Model Type: Units: Catings C	A Curves Appearance A	el CrossHelth Custom be edited. You must first o oppic v) v ess v ess v Units Nome*2 NoA NoA Nome*2 Stom*2 Stop*2	Application Data F.*.	Core .	Sav	e Config Hep	
>	Apply Close ## Close # 2013 Cerborn # 2013 Cerborn # 2014 Annealed # ASS6 Jon East # ASS1 1010 55 # ASI51 1016 55 <td>Some Stantes S Stantes S Stantes S Stantes S Stantes S Stantes S expension et of Stantes et of Stant</td> <td>Inva Config</td> <td></td> <td>Correction X Correction Appendix Append</td> <td>et CrossHetch Custom be edited. You must first of oppic v) v ess v Simm*2 Nov. Simm*2</td> <td>Application Data A</td> <td>Core .</td> <td>Sav</td> <td>e Config Help</td> <td></td>	Some Stantes S Stantes S Stantes S Stantes S Stantes S Stantes S expension et of Stantes et of Stant	Inva Config		Correction X Correction Appendix Append	et CrossHetch Custom be edited. You must first of oppic v) v ess v Simm*2 Nov. Simm*2	Application Data A	Core .	Sav	e Config Help	

Figure 5. The selection of some materials from SolidWorks 2013 library

Table 1

Material	Drip	The limit of	Poisson's	Modulus tensile	Tensile	
	limit (σ _c)	traction (σ_r)	ratio	/ compressive	modulus /	
				(E)	shear (G)	
	(N/mm^2)	(N/mm²)		(N/mm^2)	(N/mm ²)	
M1	220,590	399,83	0,28	210000	79000	
M2	248,170	482,55	0,32	200000	76000	
M3	620,420	723,83	0,28	210000	79000	

Properties of the selected material

- application load corresponding elementary resultant cutting forces *R*. According to real mode of operation (operating) of large diameter disc cutter, scenario simulation was adjusted accordingly. The load was applied at the appropriate angle α formed by the *R* force with the horizontal (figure 6).



Figure 6.Application load corresponding elementary resultant cutting forces R

- use network procedure ("meshing procedure") to break down the model into discrete elements. In general, a finite element model is defined by a network that is fully realized, a geometric arrangement of elements and nodes. Nodes are points where features are calculated, such as displacements (fig. 7).



Figure 7. 3D Model meshed into a finite element network

- running study analysis to calculate the tensile and displacement based on geometry, material, load conditions and type of meshing restriction. After running analysis studies, the results can be viewed to compare (fig. 8, 9).



Figure 8.Sequence during comparison studies and results appear on the screen as tensile von Mises distribution



Figure 9.Sequence during comparison studies and results appear on the screen displacement distribution

Results of the analysis based on technical and economic choice of metallic material of construction body active type disc knife of large diameter, fitted to the machinery for soil tillage row of trees, while cuttings root for moderating the growth of shoots foliar fertilization accuracy, are shown in table 2.

Table 2	2
---------	---

Results of the analysis based of teenmoul and evenemie energy						
		Value				
Name	Unit of measurement	Material 1 (equivalent rolled steel)	Material 2 (equivalent quality steel)	Material 2 (equivalent alloy steel)		
vonMises	N/mm ² (MPa)	51.391768	54.709508	54.834492		
Resultant displacement, mm	mm	4.8×10 ⁻²	4.647×10⁻²	4.491×10 ⁻²		
Safety factor	-	4.292	4.536	11.314		
Price	lei cu TVA / m²	111.91 [7]	118.08 [7]	942 [8]		
Price / safety factor	-	26.074	26.066	83.259		

Results of the analysis based on technical and economic choice

From the results shown in Table 2 revealed that the lowest technical and economic indicator is 26.066, which led to the choice of metallic material of the disc knife "*blackboard*"

hot rolled executed in accordance with EN 10051, allied S355J2 + N according to EN 10025", which has a high resistance in terms of a price as low as possible.

CONCLUSIONS

- The application of computer aided engineering (SolidWorks) and structural simulation (SolidWorks SIMULATION) offers design engineers a solution to perform finite element analysis (FEA) to determine the distribution of stress and deformation under the action of external forces;

- The technical and economic indicator, which is proposed to analyze the technical and economic criteria when selecting a metal material, helps reduce design validation time and enables economic and financial results as good.

ACKNOWLEDGE:

The results presented in this article were obtained with support of the Ministry of National Education and Scientific Research, the National Authority for Scientific Research and Innovation (ANCSI), the NUCLEU Programme, contract no. 8N / 09.03.2016, project PN 16 24 02 01.

BIBLIOGRAPHY

1. M. Lăutaru, T. D. Babeu, 2011, *The simulation using the finite element method to test the outer compression coil spring bogie* Y 32 *R XI*, Multidisciplinary National Conference with International Participation, Professor Dorin Paul - founder of Romanian Hydropower, Sebes.

2. E. Marin, P. Toderaşc, D. Manea, A. David, 2015, *Technical equipment for tilling the soil and root pruning row of trees*, Patent application RO-BOPI 6/2015, din 30.06.2015, http://pub.osim.ro/publication-server/pdf-

document?pn=ro130291%20ro%20130291&idocid=6956&iepatch=.pdf.

3. D. Nedelcu, 2007, *Stress Analyse of an Admission Valve with Finite Element Method*, Analele Universității "Eftimie Murgu" Reșița, Anul XIV, Nr. 1, pp 139÷144

4. M. Topakci, H.K. Celik, M. Canakci, A.E.W. Rennie, I. Akinci, D. Karayel, 2010, Deep tillage tool optimization by means of finite element method: case study for a subsoiler tine, J. Food Agric. Environ., 8 (2), pp. 531–536

5. SolidWorks Product Document, 2013, SolidWorks Simulation 2013 On-Line User's *Guide, SolidWorks Software Corp.*, USA.

6. Şandru, A., 1983, *Operation of agricultural machinery*, Didactic and Pedagogic Publishing House, Bucharest.

7. *** <u>http://www.baduc.ro/Metalurgice/TABLA-PENTRU-CONSTRUCTII/TABLA-NEAGRA-LBC</u>

8. *** http://www.altdepozit.ro/tabla-inox-p-2734.html