An Investigation Of Designing And Manufacturing The Hard-Shell Peanut Peeling Machine With A Small Scale-Size

Van Thanh Tien Nguyen, Tien Bao Tran, Truong Giang Nguyen, Huu Hao Huynh, Van Hieu To, Duc Manh Doan, The Quang Nguyen, Van Thanh Dang

Abstract: Peanuts are not only a highly nutritious nut but also play a crucial role in Vietnam's processing and exporting industry. This is a reason why there have been a wide range of machines built to support farmers in peanut production lines. Especially, in a peanut shell peeling stage, which is also a labor-intensive process and the most time-consuming in the production of peanuts. Nevertheless, the price of these devices is high and their productivity is quite large, which are unsuitable for the current conditions and production capabilities of Vietnamese farmers. Researching, designing and improving the peanut shell peeling machine with a portable size, acceptable productivity, easy assembly and replace parts, are absolutely necessary. Additionally, the aim of a research also ensures food hygiene along with environmental safety. The operation of the machine bases on the principle of two rollers. One is a rotating roller and the other is fixed. The friction created between peanuts and rollers that break the bridge of the hard shells. Afterwards, peanuts and shells would be sorted by fan blowing. Ultimately fine peanuts are brought to vibrate and classify. Through doing experiments, the machine has the highest productivity when the roller rotates with a number of revolutions of 317 rpm and a gap of two rollers is 12 mm. When these parameters are satisfied, the productivity attainted is 100 kg / hour and the scrap rate is less than 25 %.

Index Terms: Peanuts machine, hard shells peeling, fixed roller machine, rotating roller in work, the gap between two rollers

1. INTRODUCTION

TThe peanut peeling machine has productivity that relies on the friction on the hard shell of peanut with the surface of rollers. The friction depends on both a gap between two rollers and roughness of a rubber surface covering the rollers. Additionally, the number of rollers' rotation plays a crucial role influencing an impact force of rollers on a surface of peanut shells. Moreover, a length of two rollers will determine an amount of peanut peeled in a unit of time. The machine's productivity is also impacted by a moisture of peanuts this is a reason why in order to boost the productivity, decreasing the moisture is a must. Generally, roller is a common part used in a wide range of technical fields, such as presses machine or laminators. Mechanical equipment made of rollers usually has simple structures with high impact, stability, easy replacement and installation and affordability.

It is irrefutable that peanut peeling machines are widespread devices on a market due to prominence of peanut in a food processing industry. This is a reason why there are numerous machines with a wide range of operating principles which are studied and manufactured by individuals and organizations around the world. In Viet Nam, besides researches from individuals, Binh-Quan Company also conducts commercialization of the machine on the domestic market. In the world, there are machines from Josh Litwin with Universal Nut Sheller and AF1000 machine of BIONOT Company from Greek. Additionally, agriculture peeling machines are increasingly examined by technical students from the large number of universities in Vietnam with a wide variety of structures such as soybean peeling machine with two-conveyor structure [1], green bean peeling machine using dam wing structure and centrifugal fan of Nha-Trang University students according to the study of Nguyen Van Han, Duong Van Danh (2018) [2], a peeling quail eggs machine uses reverse rotation shaft [7], a peeling banana machine uses the principle of friction wheel [8], a peeling peanut machine with a two-roller structure rotating simultaneously [9], peeling onion machine using pneumatic conveyor principle [10], a peeling silk shell of peanut machine utilizing a four-roller structure rotating synchronously [11]. THIS PEANUT PEELING MACHINE HAS AN ABILITY TO SATISFY THE DEMAND OF CURRENT PRODUCTION CAPACITY IN VIETNAM WITH A SIMPLE STRUCTURE. FURTHERMORE, THE MACHINE CONVEYS VAST FEASIBLE MERITS TO FARMERS DURING THE PROCESS OF PRODUCING PEANUT. ALONG WITH REASONABLE MANUFACTURING COSTS, THIS EQUIPMENT PROMISES TO BE MORE OPTIMAL COMPARED WITH OTHER DEVICES WITH DIFFERENT KINDS OF STRUCTURES. NEVERTHELESS, THE MACHINE STILL HAS A FEW DRAWBACKS SUCH AS PARTIALLY CLASSIFYING FINE ULTIMATELY PRODUCTS AND SHELLS, A RESTRICTION OF VOLUME OF INPUT PEANUT AND THE REQUIREMENT OF SIMILAR SIZE OF INPUT MATERIALS IN ORDER TO ATTAIN THE OPTIMAL PRODUCTIVITY. IN FACT, THE SAME TYPE OF EQUIPMENT ON THE MARKET THESE DAYS IS VERY DIVERSE IN TERMS OF DESIGN WITH IMMENSE PRODUCTIVITY. HOWEVER, IT IS UNDENIABLE THAT THERE ARE STILL FEW MACHINES THAT ARE REALLY FIT FOR SMALL SCALE PRODUCTION IN VIETNAM. THIS IS A REASON WHY THE STUDY AND MANUFACTURE OF PEANUT PEELING MACHINE WITH IMPROVED STRUCTURE IS COMPLETELY CONSISTENT WITH THE CURRENT SITUATION.

2 OPERATING PRINCIPLES

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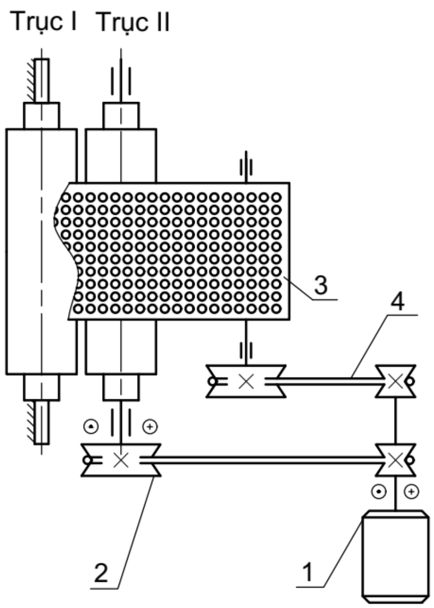
The process of peeling peanut that is to break the bridge of peanut shells with the principle of using two rollers which is installed parallel to each other, with one rotating and the other fixed with an adjustable gap between them. The first step involves feeding dried peanut into a feeding hopper after that peanut is oriented to fall into the gap between two rollers. At this time, the peanut is influenced by the force set up by two rollers, which is massively implicated by a rotational speed of the rotating roller as well as the roughness of the rubber covering the surface of two rollers. After being broken by the force, peanuts and shells fall to vibrating sieve consisting of two floors with different circular meshes, which plays the most important role to distinguish between fine and broken peanut. Simultaneously, the peanut shells are blown out in the opposite direction thanks to the fan blowing.

1) An engine, 2) Belt transmission for rotating roller, 3) Vibrating



sieve, 4) Belt transmission for vibrating sieve

Fig. 1 *A diagram of operational principle*

There is no room for doubt that it is necessary to determine the needed force for opting the applicable gap. In order to calculate the dissection force, we carried out a series of experiments by the Brookfield CT-3 Texture Analyzer of the Institute of Biotechnology and Food Technology, Ho Chi Minh City University of Industry (IUH) and we arrived at a conclusion that the necessary dissection force is 52 N. Due to the force above, the rotational speed and the gap between two rollers are estimated, which lead to an assurance that the machine has fine product greater than 75 %.The peeling peanut machine are examined and achieves a performance with 76.71 % at Hong-Luu Mechanical Processing Company, Ho Chi Minh City, Vietnam with input materials are dried peanut. The rotational speed of the roller and the gap between two rollers can be adjusted to be correct with all sorts of peanut.

The Fig. 1 illustrates an operating principle of the peeling peanut machine. Initially, raw peanuts are loaded into a middle of the gap between roller I and roller II. The next step is when the roller II rotates thanks to a belt transmission (2), pressing the peanut to roller I which takes responsibility for breaking the peanut's shell and falling to the vibrating sieve (3) which operates with the assistance of the belt transmission (4). Eventually, the peeling process finishes when broken peanut is screened the shell and a kernel by the sieve tray and the blowing fan

3 CALCULATION, DESIGN AND MANUFACTURE

3.1. Determine the breaking force of the peanut shell link and choose the engine

It is indisputable that there is a need to determine exactly the required force to damage a bridge of peanut shell, we utilize CT-3 structural analyzer of the Institute of Biotechnology and Food, Industrial University of Ho Chi Minh City (IUH), which can calculate automatically through compression data and tensile strength and some physical properties related to evaluating food and other consumer merchandises. The CT3 machine abounds in head such as: bending, compressing, piercing, compressing, stretching, extruding, friction, ... thereby assessing the criteria: hardness, toughness, crunchy, softness, degree elasticity, deformation, gel bloom, ... after being analyzed carefully, we recognize that the compressing probe has a spherical shape that most accurately simulates the contact between the two rollers and the peanut shells. Consequently, we measure breaking peanut shell force using a spherical compressing probe via CT-3 structural analyzer under the guidance of lecturer Nguyen Tat Son of the Institute of Biotechnology and Food Ho Chi Minh City University of Industry (IUH).

Fig. 1 *Brookfield CT-3 Texture Analyze Machine*

The Fig. 3 indicates a complete process of implication of the sphere probe on the peanut surface. Initially, the process happens for 9 seconds with beginning force of 10N. It is easy to see that in the first one-second period the force soars fourfold to reach a peak at 40 N. At that time, a contact area of the probe and shell is divested, the machine no longer exerted force on this area and then pulled the probe back to an original position. Subsequently, from 1.5 seconds to 6.5 seconds, the machine applies additional force of approximately 37 N to flatten the connection of peanut shell.

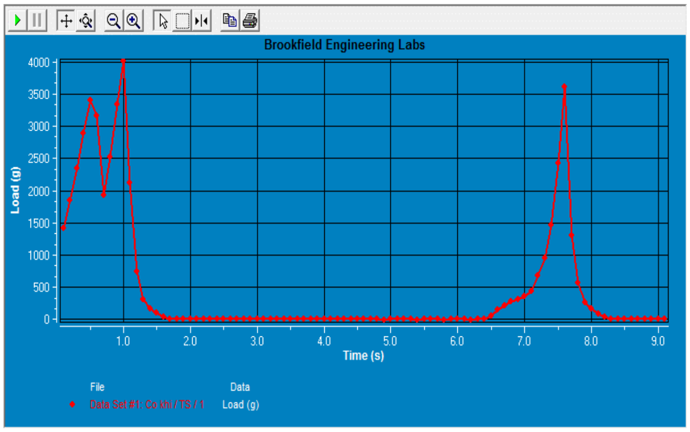


Fig. 2 *Force diagram of one sample*

The Fig. 4 presents Fig.s synthesized the 10-measurement, each one contains ten samples but the only final one consists of nine samples. As can be seen from the Fig. that the adequate force to destroy a contact of peanut's shell of 99 samples fluctuates in a range of the lowest point 10 N to the highest position 52 N with essential time varies from 0 to 28.7 seconds. Based on a diagram, we find out that in order to operate stably and completely damage a contact of peanut's shell, the optimum force should be the largest force 52 N.
Each measurement, 10 samples were analyzed at different locations on unshelled peanuts (only nine samples were used for the last measurement).

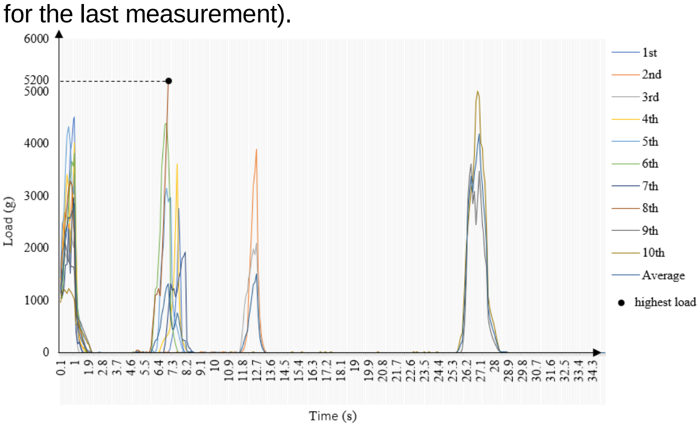


Fig. 3 *Summary of the fluctuation of 99-sample load forces*

From the CT-3 structural analyzer, it is determined that the indispensable force for breaking peanut shell is 52 N.
Calculated capacity:

$$P_{tt} = \frac{F \times v}{1000} = \frac{52 \times 12}{1000} = 0.624 \quad \text{kW [3]} \qquad (1)$$

Required power on the motor shaft:

$$P_{dc} = \frac{P_{tt}}{\eta_{ol} \times \eta_d} = \frac{0.624}{0.99 \times 0.85} = 0.742 \quad \text{kW [3]} \qquad (2)$$

With the assistance of given comparison criteria, the engine must meet the requirements including the portable design to fit the scale of the machine. Additionally, its capacity and speed of rotation must match the needs. Furthermore, the engine must also satisfy the diverse orders requirements of the different companies. From mentioned demands, opting a YL90L-4 engine with a capacity P = 1 HP and the number of revolutions n = 950 rpm.

3.2. Select and manufacture vibrating sieve

TABLE 1

CHOOSING A TYPE OF VIBRATING SIEVE

Plan	A-Flat sieve	B-Rotary tube sieve	C-Classifying tube
Price Structure	Low (5 points) Simple, space-saving installation (4 points)	Low (5p) Simple, dependent on installation space (4 points)	High (3 points) Complicated, large installation space (3 points)
Classification ability	Numerous different sizes (5 points)	Unable to separate mixes of nearly equal size, large omission proportion (3p)	Typically used for separating rice and plate after milling (3 points)
Total score	14 points	12 points	9 points

Table 1 compares the three most common kinds of vibrating sieves in practice. Based on a point ladder from 1 to 5 to assess characteristics of each type, via the evaluation of fundamental criteria such as price, structure, classification ability to get the total points for each plan. Obviously, in the total score of three evaluated plans, plan A has the highest final score with optimal merits compared with other methods. As a consequence, we opt the Plan A-Flat sieve.

3.3 Durable calculation of roller II

According to Fig. 5 we calculate parameters:

Useful ring force $F_{t2} = 61.83$ N

Impact force on the shaft $F_{r2} = 358.5$ N

Initial tension force $F_0 = 187.2$ N

Fig. 5 demonstrates a diagram interpreting the impact forces on roller II in coordinate system Oxyz

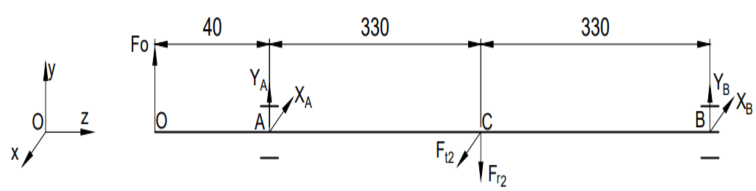


Fig. 4 *Force distribution on the shaft II*

From Fig. 5 in xOz plane:

$$\sum M_A = 0 \Leftrightarrow F_{t2} \times 330 - X_B \times 660 = 0 \qquad (3)$$

$$\Leftrightarrow 61.83 \times 330 - X_B \times 660 = 0$$

$$\Leftrightarrow X_B = 30.915 N$$

$$\sum M_B = 0 \Leftrightarrow X_A \times 660 - F_{t2} \times 330 = 0 \quad (4)$$

$$\Leftrightarrow X_A \times 660 - 61.83 \times 330 = 0$$

$$\Leftrightarrow X_A = 30.915 N$$

$$\sum F_{kx} = 0 \Leftrightarrow -X_A + F_{t2} - X_B = 0 \quad (5)$$

Testing:

$$\Leftrightarrow -30.915 + 61.83 - 30.915 = 0$$

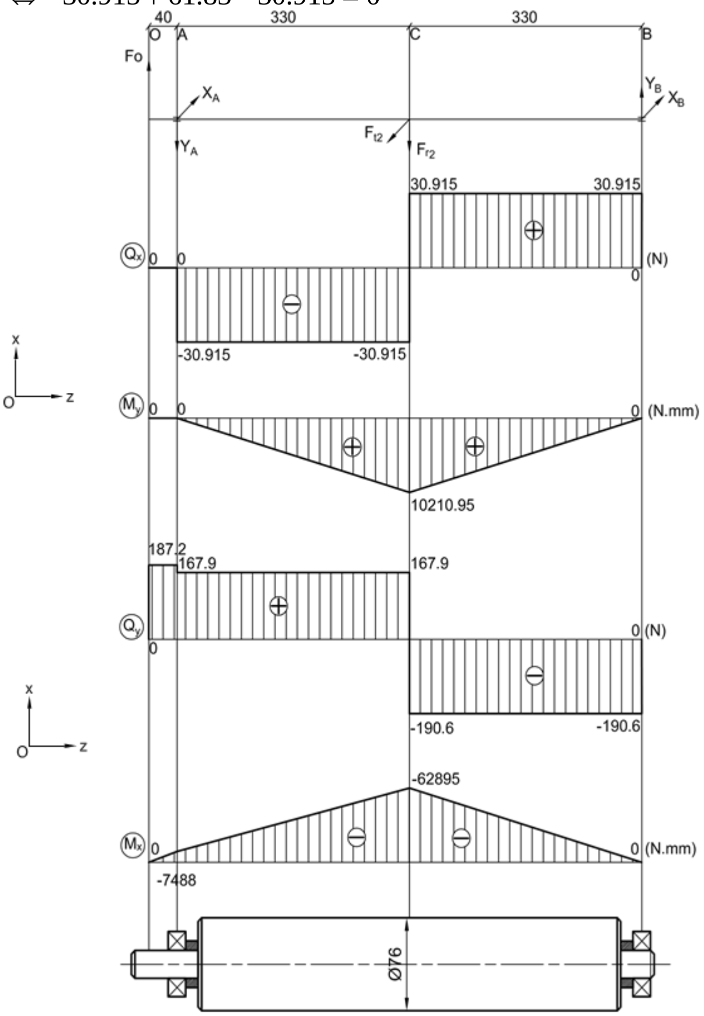


Fig. 5 *Diagram of internal force and axial moment II*

In yOz plane:

$$\sum M_A = 0 \Leftrightarrow -F_0 \times 40 - F_{r2} \times 330 + Y_B \times 660 = 0 \quad (6)$$

$$\Leftrightarrow Y_B \times 660 = 187.2 \times 40 + 358.5 \times 330 \Leftrightarrow Y_B = 190.6 N$$

$$\sum M_B = 0 \Leftrightarrow -F_0 \times 700 + F_{r2} \times 330 - Y_A \times 660 = 0 \quad (7)$$

$$\Leftrightarrow Y_A \times 660 = -187.2 \times 700 + 358.5 \times 330 \Leftrightarrow Y_A = -19.3 N$$

(Contrast hypothesis)

$$\sum F_{ky} = 0 \Leftrightarrow F_0 + Y_A - F_{r2} + Y_B = 0 \quad (8)$$

$$\Leftrightarrow 187.2 - 19.3 - 358.5 + 190.6 = 0$$

3.4 Calculating a base frame

Table 2

Table of properties analysis of steel types

Steels	Illustrating pictures	Benefits	Disadvantages
U shaped		High strength High durability in divergent weather conditions	Unsuitability for small structures of mechanical machines Popularizing in construction fields
I shaped		Popularly used in a variety range of construction projects Withstanding high pressure and widely used in factory and civil constructions	Bearing loads better in vertical Weak twist resistance
Square shaped		Modest production cost Long duration Easily shaping frame structure of mechanical machines	Low roughness Quite low aesthetic

From given comparisons on table 2 and table 3, it is easily seen that square shaped steel does not only have more optimal advantages but also is apt for the structure of peanut shelling machine than the other two types of steel. So, the frame is fabricated by square shaped steel.
Durable test of square shaped steel:
We must consider material strength conditions to guarantee balance of the structure of metal bar materials

Table 3.

Formula of material strength conditions

Testing durable conditions	Testing stable conditions
$\sigma = \dfrac{P}{A_g} \le [\sigma]_n$ [4]	$\sigma = \dfrac{P}{A} \le [\sigma]_{Stb}$ [4]

In practical occasions, assuring stable conditions also ensures durable conditions that's why we only consider bars in stable conditions
Stable conditions:

$$\sigma = \frac{P}{A} \le \varphi[\sigma]_n$$ [4]

(9)

Bar parameters: square shaped steel with a length of 900 mm,

made of CT3 steel with allowable compressive stress
$[\sigma]_n = 40\ kN / cm^2$
Compressive force Pm

An assumption for thinness
$\lambda = 100 \Rightarrow \varphi = 0.6$ [4]
Transforming the (9) formula for the selection of section:

$$A \geq \frac{P}{\varphi \times [\sigma]_n} = \frac{1.17}{0.6 \times 40} = 0.049 cm^2 \quad (15)$$

Fig. 7 shows the cross-sectional section of the bar with parameters h being the height, b is the width, t is the thickness of the steel and C is the center of the section. The cross-sectional section is divided into four thumbnails and numbered from one to four with the center of each Fig. being x. From these 4 small focal points will be determined in C center of the section.

Table 4
Base plate parameters

Size (mm)			Weight (kg/m)
H	B	T	
40	40	3	3.46

Opting square shaped steel with the following size:

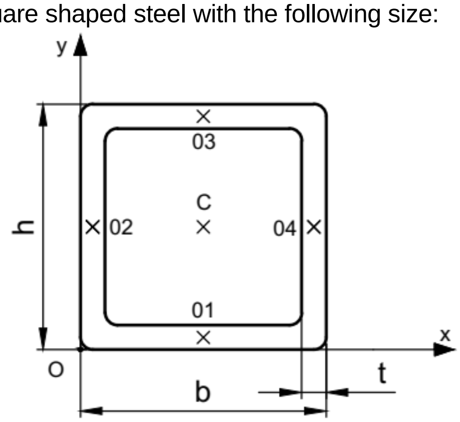


Fig. 6 *Cross section of bar [4]*

Find the C center of steel:

$$X_c = \frac{S_y}{A} = \frac{\sum_{i=1}^{n} A_i \times x_i}{\sum A_i};$$

$$Y_c = \frac{S_x}{A} = \frac{\sum_{i=1}^{n} A_i \times Y_i}{\sum A_i} \quad [4]$$

O1 center:

$$X_1 = \frac{b}{2} = \frac{40}{2} = 20mm;$$

$$Y_1 = \frac{t}{2} = \frac{3}{2} = 1.5mm;$$

$A_1 = (40 - 6) \times 3 = 102$ mm2

O2 center:

$X_2 = \frac{t}{2} = \frac{3}{2} = 1.5$ mm;

$Y_2 = \frac{h}{2} = \frac{40}{2} = 20$ mm;

$A_2 = 40 \times 3 = 120$ mm2

O_3 center:

$X_3 = X_1 = 20$ mm;

$Y_3 = h - \frac{t}{2} = 40 - \frac{3}{2} = 38.5$ mm;

$A_3 = A_1 = 102$ mm2

O4 center:

$X_4 = b - \frac{t}{2} = 40 - \frac{3}{2} = 38.5$ mm;

$Y_4 = Y_2 = 20$ mm;

A4 = A2 = 120 mm2

$$\Rightarrow X_c = \frac{s_y}{A} = \frac{(20\times102)+(1.5\times120)+(20\times102)+(38.5\times120)}{102+102+120+120} = 20\ \text{mm}$$

$$\Rightarrow Y_c = \frac{s_x}{A} = \frac{(1.5\times102)+(20\times120)+(38.5\times102)+(20\times120)}{102+102+120+120} = 20\ \text{mm}$$

Moments of inertia:

$$I_{xl} = \frac{b_l \times h_l^3}{12} = \frac{40 \times 40^3}{12} = 213333.33 mm^4 \quad [4]$$

$$I_{yl} = \frac{h_l \times b_l^3}{12} = \frac{40 \times 40^3}{12} = 213333.333 mm^4 \quad [4]$$

$$I_{xN} = \frac{b_N \times h_N^3}{12} = \frac{34 \times 34^3}{12} = 111361.33 mm^4 \quad [4]$$

$$I_{yN} = \frac{h_N \times b_N^3}{12} = \frac{26 \times 26^3}{12} = 111361.33 mm^4 \quad [4]$$

Total inertia moments:

$$I_x = I_{xl} - I_{xN} = 213333.33 - 111361.33 = 101972.3\ mm^4 = 10.2 cm^4$$

$$I_y = I_{yl} - I_{yN} = 213333.33 - 111361.33 = 101972.3\ mm^4 = 10.2 cm^4$$

$$\Rightarrow I_x = I_y = 10.2\ cm^4$$

$$r_x = r_y = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{10.2}{444 \times 10^{-2}}} = 1.52\ \text{cm}$$

Fig. 8 presents that when axial compression force grows, greater than a critical value P < Pth, the bar does not return to the original straight position but continues to bend further. This equilibrium of bars is unstable. Since the curved bar will appear bending in the bar, the stress and strain increase and the bar

may be destroyed.
Because the bar bears radial compression and the bar link should be available with $\mu = 2$

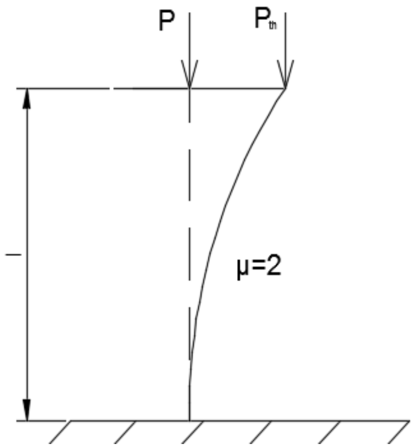


Fig. 7 *Instability and coefficient μ [5]*

Testing selected section with the real axis x:

$$\lambda = \frac{\mu \times l}{r_x} = \frac{2 \times 750}{15.2} = 98.68 \quad (17)$$

Value gets close to hypothesis so that's satisfied
With $l = \mu \times l$ is the equivalent length of the bar. [5]
Including: l is the true length of the bar
μ is one of the chosen stability factors
Checking the condition again:

$$\sigma = \frac{P}{A \times \varphi} \le [\sigma]_n \Leftrightarrow \frac{1.17}{0.6 \times 444 \times 10^{-2}} = 0.44 \le 40 \frac{kN}{cm^2}$$

(Eligible)
We choose CT3 square shaped steel because it satisfies the stable conditions of the compression bar.

4 RESULTS AND DISCUSSIONS

4.1 Stress distributed on the frame

Fig. 9 shows that the most perilous position at A with the maximum stress of the load frame is 20.246 N/mm^2 equivalent to 20.246 kN/cm^2 less than the permissible stress of the bar: $[\sigma]_n = 40\ kN/cm^2$

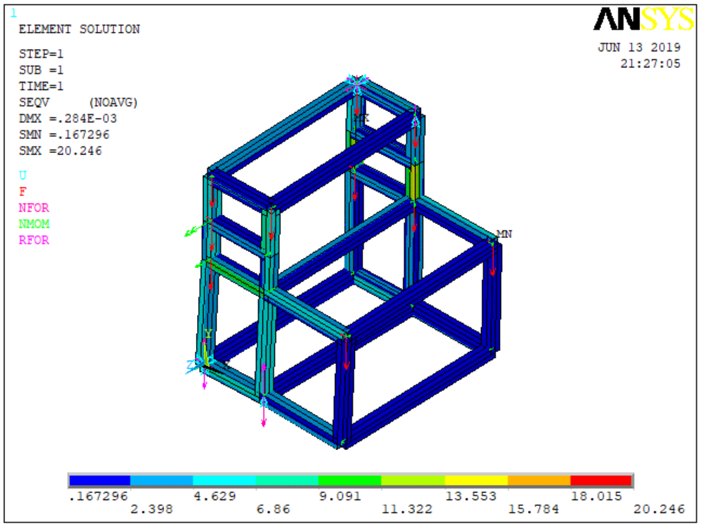


Fig. 8 *Stress distributed on the chassis by ANSYS software*

4.2 Experimental results

The Fig. 10 demonstrates the peanut peeling machine is fabricated altogether and tested at Hong Luu Mechanical Processing Co., Thu Duc District, Ho Chi Minh City, Vietnam with input materials that are peanuts dried after harvesting. The rotational speed of the roller as well as the gap between the two rollers can be adjusted to suit different types of peanuts.

The experiment is carried out respectively with 7 levels of gap from 11 mm to 14 mm (distance of each adjustment was 0.5mm) and the moisture levels of input materials after measuring includes: 0.47, 0.51, 0.54 and 0.55 %. For each experiment, 200 g of dried peanuts are put into the machine, then the number of separated peanuts are taken to statistics on the collected components (finished products, waste products, shells)
in which peanuts are considered as finished products including unbroken peanut and half-broken peanuts. The correlative results of moisture and a gap towards productivity are illustrated by line graphs below.

Fig. 9 *Designed machine*

Fig. 11 describes the distance measure TPG-700A-Niigata to measure the gap of two rollers with the parameters shown in Table 5.

Fig. 10 *Ruler due to gap TPG-700A-Niigata*

Table 5

Parameters of gap gauge TPG-700A-Niigata

Parameter	Values
Measuring range (mm)	1~15
Accuracy (mm)	±0.05
Divisibility(mm)	0.1
Taper angle (o)	7°9'10"
Leaf length(mm)	148.5
Leaf thickness (mm)	1.2
Weight (g)	10

Fig. 12 presents the MA150 device that is used to measure peanut moisture at the Institute of Biotechnology and Food (IUH). The machine applies heat radiation infrared mechanism to determine the moisture of samples.

4.3 Experimental results 1

Fig. 11 *The relationship chart between the rate of finished product with the gap between the roller and the moisture content of the peanut*

The Fig. 12 compares the influence between the gap and the peanut moisture against the rate of fine product. Generally,

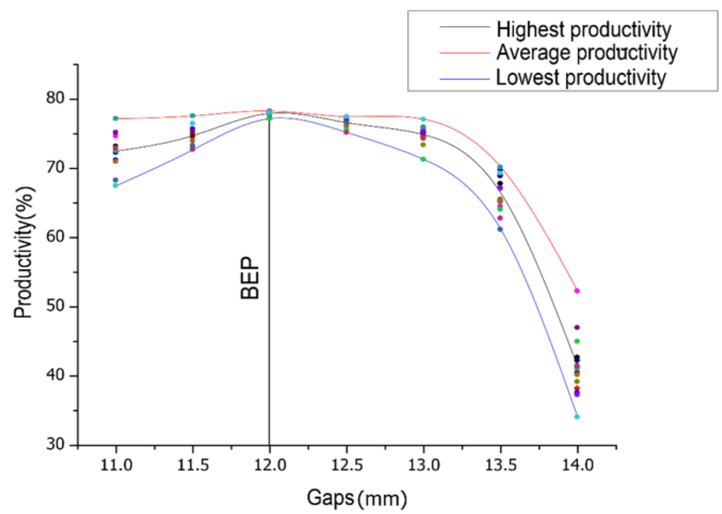


Fig. 12 *Results of the moisture content of 1 sample after measurement with the MA150*

when the gap jumps, all four-type peanut with different moisture levels witness a decline in the proportion of finished product. Apparently, in the gap range from 11 mm to 12 mm see the same trend of four types of peanut with different moisture. When peanut with moisture of 0.47 % and 0.51 % the productivity gradually grows and reaches the best position point (BEP) at approximately 79 % at the gap at 12mm and the moisture of 0.47 %. Along with this gap range, peanut with moisture of 0.54 % and 0.55 % shares the same trend when maintaining the percentage of productivity of 73 % in a gap between 11 mm and 11.5 mm before slightly goes up to nearly 77 % at 12 mm. From a gap greater than 12 mm, all sorts of peanut experience a significant reduction in productivity bringing down from virtually 77 % - 79 % to the bottom at 35 % at the largest gap of 14 mm.

4.4 Experimental results 2

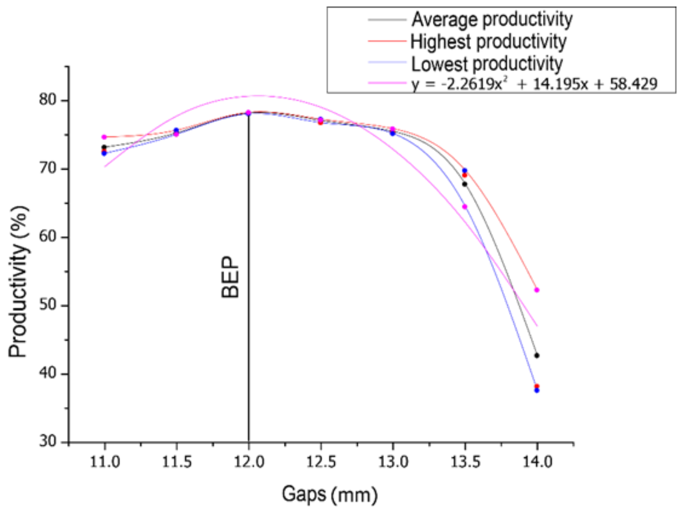


Fig. 13 *The relationship lines chart between the finished product rate and the gap between the rolls*

Fig. 14 describes when the gap between two rollers is increased from 11 mm to 12 mm, the machine's productivity goes up gradually from 73.2 % to the highest level (BEP) of 78.2 % at 12 mm. By contrast, when continuously increasing the distance between the two rollers from 13mm to 14mm, the machine productivity slightly decreases and reaches the lowest level when the distance is 14 mm with a average performance of only 42.7 %. Therefore, from the graph it can be concluded that the best distance is 12 mm.

4.5 Experimental results 3

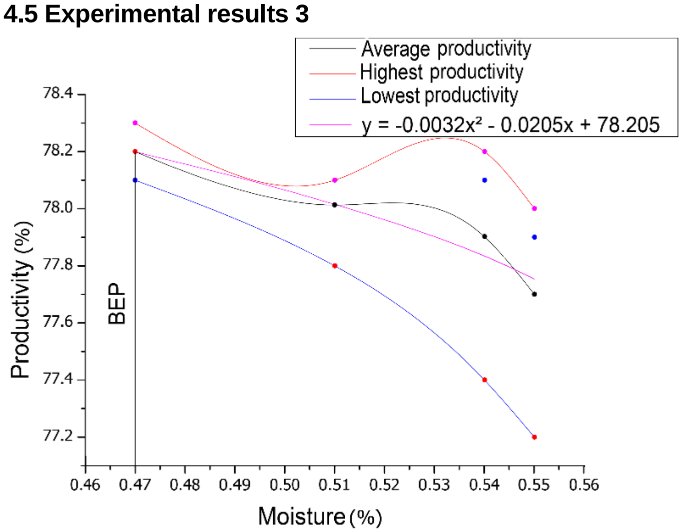


Fig. 14 *The relationship chart between the rate of finished products and the moisture content of peanuts*

Fig 15 demonstrates the relevance between moisture and fine product. Generally, the more a moisture climbs, the more percentage of finished products falls. When the moisture accounts for from 0.47 to 0.51 % the rate of finished product decreases slowly from the best efficient point at 78.2% to 78%. In the moisture range from 0.54 to 0.55, there is a significant decline in the proportion of finished products, decreased more than 2%, from 77.9% to less than 77.7%.

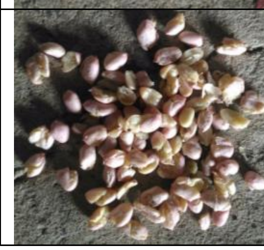
Materials	
Fine products	
Chips	

Fig. 15 *Peanuts before and after experiment*

Fig. 16 shows peanut materials and products before and after peeling using manufactured machines in the Fig.. Of the total number of unseparated seeds there are non-separable and moist seeds. In order to boost the efficiency of the machine in terms of productivity, it is necessary to select the input material with uniform size and good quality and low humidity.

CONCLUSIONS

The peanut peeling machine is designed and manufactured successfully. Via initially experimental process of 25 kg of raw material, the machine experienced a preliminary productivity of 76.71 % with a time that is only half as much as manual methods. The results justify that when the gap between 2 rollers is 12 mm and the moisture is 0.47 %, the proportion of peanut seeds separated from the shell is the largest. Conversely, when the gap is less than 12 mm, or larger and equal to 13 mm and the moisture is greater than 0.47 %, peanuts are easily broken into pieces or cannot completely separate shells and seeds to meet the mentioned needs. Hence, this study has achieved the objectives set out with the highest machine productivity when the gap between the two rollers is 12 mm and the moisture is 0.47 %.The machine partly satisfies the current market demands with reasonable fabrication costs, easy and convenient maintenance and replacement of parts. Particularly, this machine is environmentally friendly and meets food hygiene and safety criteria.

Table 6

Symbols utilized in the article

No	Symbol	Name	Unit
1	F	Force breaking the peanut shell link	N
2	F_{kx}	Force in direction x	N
3	F_{ky}	Force in direction y	N

4	F_t	Useful tangential force	N
5	F_0	Original belt tension	N
6	m_1	Mass of roller 1	kg
7	m_2	Mass of roller 2	kg
8	M_A	Moment impacts on point A	N.mm
9	M_B	Moment impacts on point B	N.mm
10	P_{dc}	Required power on the motor shaft	kW
11	P_{tt}	Calculated capacity	kW
12	Mx_A	Moment acts on point A in the x direction	N.mm
13	My_A	Moment acts on point A in the y direction	N.mm
14	v	Roller speed	m/s
15	Y_B	Force acts on point B in the y direction	N
16	Y_A	Force acts on point A in the y direction	N
17	X_A	Force acts on point A in the x direction	N
18	X_B	Force acts on point B in the x direction	N
19	η_d	Belt transmission productivity	
20	η_{ol}	Bearings productivity	
21	$[\sigma]_n$	Compression durable limit	kN/cm^2
22	$[\sigma]_{Stb}$	Stable durable limit	kN/cm^2
23	P_m	Axial compression force	kN

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