DESIGNING AND TESTING OF A TRIPOD USED FOR EMERGENCY SITUATIONS

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ABSTRACT: This article aims at designing and testing a new device for dynamic testing to people in emergency rescues in the shape of a tripod. It must be designed in such a way that its operation is in maximum safety conditions, especially knowing that this equipment is used in the field where lives are in danger. The virtual model design is made so that all legs are mobile (three feet can adapt to the desired surface, if necessary). After designing the model, it was tested with specific conditions to limit its operation using Creo software package. The tripod is tested by applying a 30000 N load. This study includes the determination of joint reactions, the connecting elements and test cases for different positioning of the tripod legs.

KEY WORDS: package Creo, tripod, anchor flange, claw fixing.

1 INTRODUCTION

Due to the numerous emergencies, there is a strong demand for development and inventing efficient devices in saving people. Development proposed devices are search robots arm, expandable arm, pulleys, tripods etc. A rescue device is effective when it can be used by several people at the same time (Stefano, 2006).

At present, tripods, used to rescue people in emergencies, are generally mostly manufactured in two ways: tripods with 3 fixed legs and 2 fixed and one movable leg.

The complex tripod for people's rescuing is a innovative device used in highly critical situations such as saving people / animals in various hazardous environments. With this device, firefighters can intervene more quickly and effectively than with other accessories, which saves time for action, essential time for victim's life.

Tripods for people's rescue are widely used in almost every well developed country. With these devices, firefighters intervene more quickly in the rescue of persons, process, some time ago it was much more difficult and arduous.

Their performance is based on the extraction of humans and animals from hazardous environments (Ciabo,1982).

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By lifting people or animals from different environments, tasks exerted on the tripod lead to the emergence of forces and moments in its entirety. Therefore it is very important to accurately calculate the tension status of the components that form the tripod (Dan, 2013).

For this study case, tripod must withstand very heavy namely a weight of 300kg, this weight will be considered and a safety factor of 10 (c = 10), resulting in a total load of 3000kg.

We used the software package Creo of the PTC Inc for the tripod design, PTC Inc (private company , interoperable design software product that provides fast recovery time). It helps engineers to stay connected to their ideas and development processes that can now be turned into reality

Creo software package has numerous benefits, which are:

- package integrated conceptual design, detail and execution;
- simulations and preparation of manufacture;
- simulations and analysis of virtual models;
- the possibility of being compatible with all instruments CAD (Computer Aided Design), (Randy, 2011).

The package consists of nine applications: Creo Direct, Creo Simulate, Creo Layout, Creo Schematics, Creo View MCAD, Creo View ECAD, Creo Sketch, Creo Options Modeler si Creo Illustrate (Randy, 2011).

2 TRIPOD DESIGN

In Figure 1. designed tripod is observed. It consists of two main parts: subassembly connecting and supporting subassembly. As stated, the tripod legs can be adjusted individually, and block with three predefined positions. By combining the three positions of the legs, we have seven cases of positioning (operation) of the tripod [8].

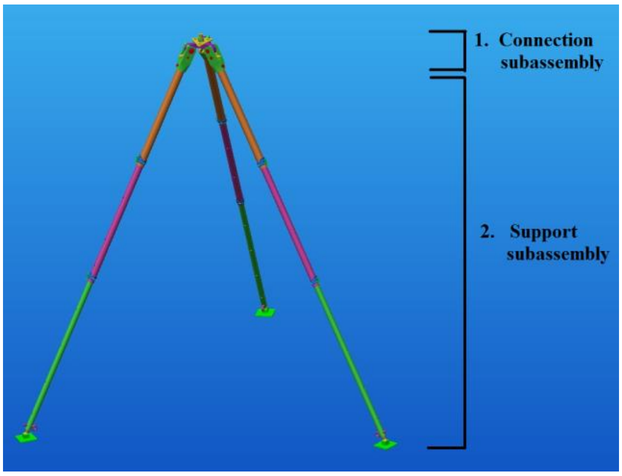

Figure 1. Tripod Redesign.

Here you can see in detail each subassembly of the tripod (Randy, 2013).

2.1 Connection subassembly

Figure 2. consists of three elements (fixing body; retaining ring; anchor flange), serving to allow movement of the legs in the working direction desired to support the force acting on the tripod.

The connecting body (2) is the main element of the tripod, with three tabs positioned at 120º to each other. Each tab has protrusions on the outside allowing locking legs in different working position (30 °, 60 °, 90 °). The central part of the piece has a hole through which the load bearing ring (useful weight).

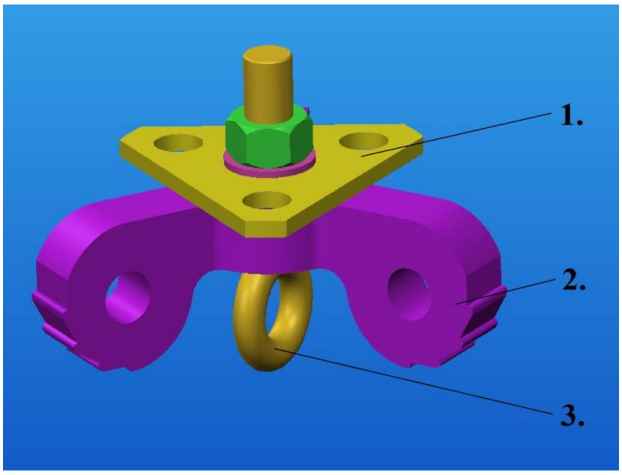

Figure 2. Connection subassembly (1-anchor flange, 2-fixing body, 3-retaining ring).

Anchoring flange (1) is positioned on the upper side of the connecting body, being attached to it by the support ring. The flange has a triangular shape (equilateral triangle), and each corner has a hole that allows the tripod anchored by cables or ropes.

The retaining ring (3) is intended on the one hand to secure the flange to the body of the fixing anchor and, on the other hand to support the useful weight (Daisuke, 2006).

2.2 The support subassembly

The support subassembly **(**Figure 3.**)** is composed of cylindrical hinge, telescopic legs (sections), locking sections system and supporting and anchoring system, and is designed to allow placement and safe operation of the entire device.

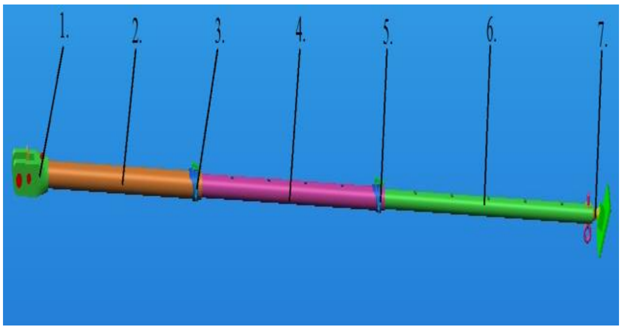

Figure 3. Support subassembly; (1- cylindrical hinge, 2, 4, 6 –telescopic legs (sections), 3, 5- locking sections system, 7- support and anchoring system).

Next there is a detailed presentation of the main elements of the subassembly support.

In Figure 4.a) the cylindrical joint is assembled on the ear by means of the bolt holding body (1). This hinge allows rotation and fixation of feet desired working position. Positioning and locking the leg in the desired position is achieved by means of the clamp (2), actuated by the spring (3).

For ease of operation and fixing a telescopic leg has been designed a lock of sections Figure 4 b). This serves to lock the linear movement of the sections of the telescopic system in the required working position.

Section blocks is performed in two diametrically opposed points. Operation of the lock is performed by activating the valve sections (1) on the locking piston (2). The pistons running a bilateral translational motion perpendicular to the sections axis.

Telescopic leg consisting of three sections Figure 4. c), is designed to support the useful weight, while allowing adjustment of the length (maximum length is 4 m).

All sections have different lengths, and diameters chosen form fits enabling telescopic adjustment system.

The geometrical dimensions of the sections are:

-Section 1: D1 = 50 mm, d1 = 40 mm, h1 = 1500 mm;

-Section 2: D2 = 60 mm, d2 = 50 mm, H2 = 1330 mm;

-Section 3: D3=70 mm, d3=60 mm, h3=1230 mm.

We used three sections because we considered the proper place for storing them in a fire truck which has a length of 1600 mm.

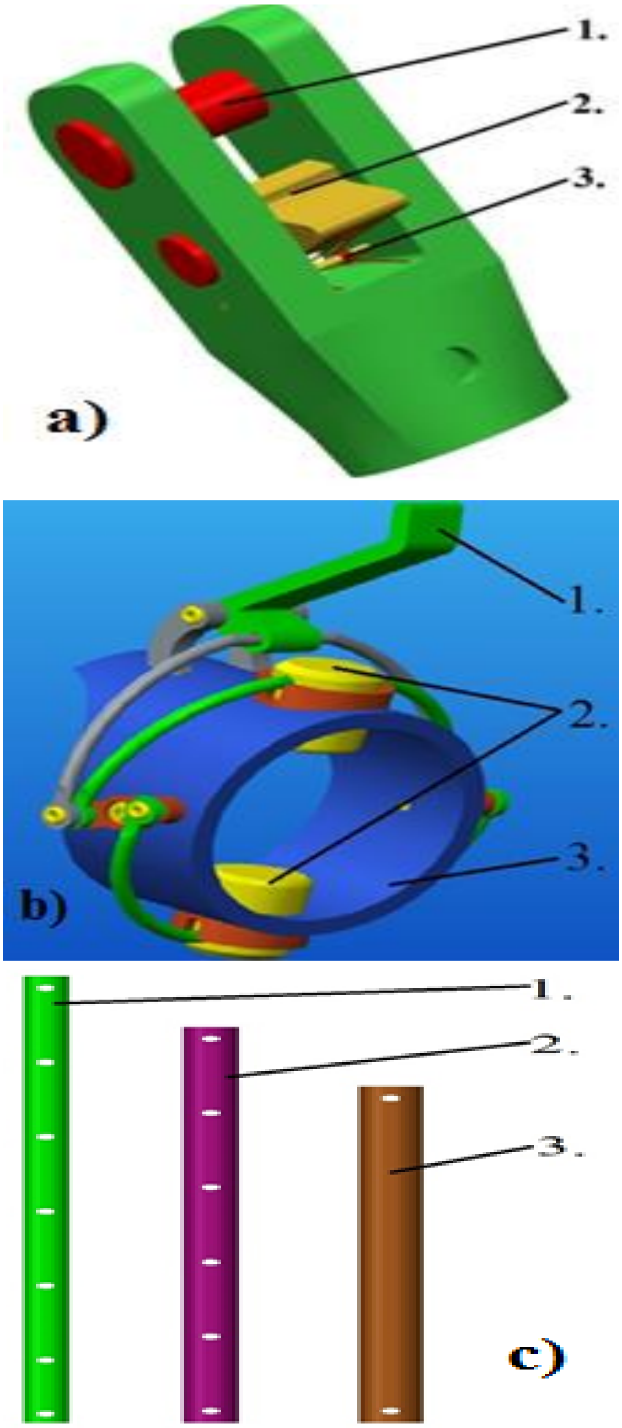

Figure 4. Elementele componente ale subansamblului de susținere: a) cylindrical hinge; b) locking sections system; c) sections;

In operation the tripod should be stable, so we designed two ground mounting systems:

Soles with support and anchoring role. These elements are designed to allow telescopic legs a placement and additional anchoring on different surfaces (Randy, 2014).

Depending on the type of soil (surface) can be used different systems of support and anchorage (foot and claws support).

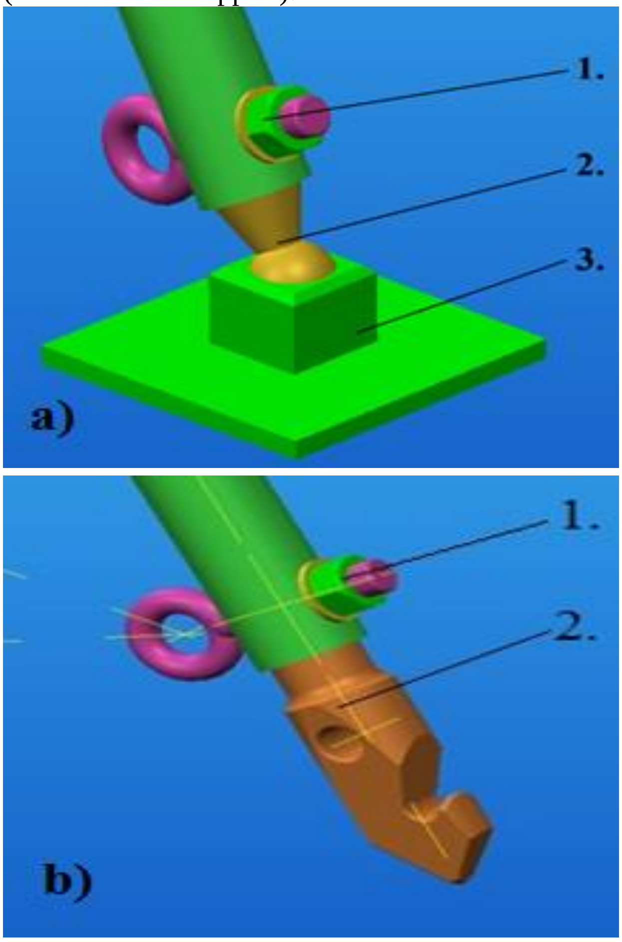

Figure 5. Fixing system, on the ground: a) sole plate (1- bolt, 2-ball joint, 3-sole plate), b) claw fixing (1- bolt, 2- claw);

In figure 5. a) sole design support is observed. The flat surface of the base prevents the penetration of soil so that the system can be used on soft surfaces (sand, marsh, mud etc.)

Claw fixing design Figure b) which is designed to allow force targeting the top of the locking claw and blocking it on various hard surfaces (rocks, roads, floors etc). For a strong stance, the claw shape allows it to be placed in various fissures, cracks and holes (Wolf, 2003).

In conclusion, tripod design has 185 landmarks, a 60kg weight and allows safety and operational needs, in the same time allowing 7 positioning cases;

The tripod design has the following advantages:

- The possibility of independent movement of the feet;
- The upper-level locking telescopic leg;
- The lock of sections;
- The lower-level stability and anchoring,

and as disadvantage we can consider weight.

3 TRIPOD DESIGN TESTING

The direction of force application shall be deemed to be perpendicular to the ground. Testing was done considering a force of 30000 N, resulting from the application of the maximum load of 3000 kg.

The force F applied to the tripod Figure 6 a) decomposes on to the three legs Figure 6. b), the components R1, R2, R3, which are oriented leg axis directions.

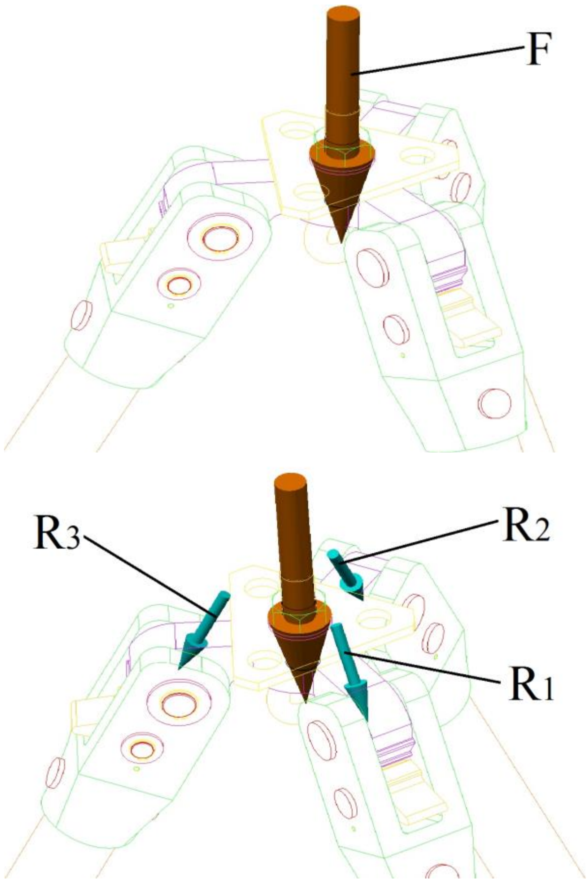

Figure 6. a) Forces on to the tripod, b) Force components;

Following analysis, found that forces change their values depending on the angle between the axis and the axis of symmetry of the tripod legs, thus forming seven test cases presented in Figure 7. The resulting values for all cases are presented in Table 1.

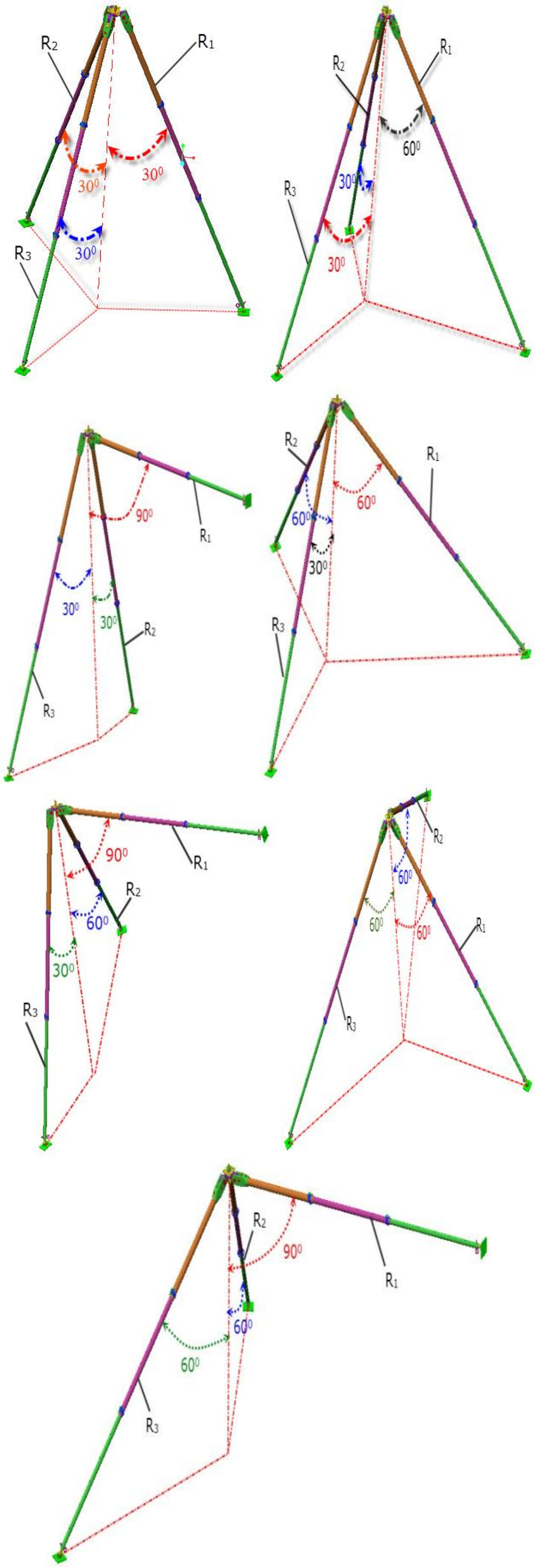

Figure 7. Legs positioning.

Table 1. Values resulting from the decomposition of forces.

Possible cases	R_1 [N]	R_2 [N]	R_3 [N]
Case 1 **30º- 30 º - 30 º**	11140	11140	11140
Case 2 **30 º - 30 º - 60 º**	15263	10645	10645
Case 3 **30 º - 30 º - 90 º**	**4977**	16502	16502
Case 4 **60 º - 60 º - 30 º**	16612	16612	7959
Case 5 **30 º - 60 º - 90 º**	8396	20324	16121
Case 6 **60 º - 60 º - 60 º**	15869	15869	15869
Case 7 **60 º - 60 º - 90 º**	13411	**22763**	22763

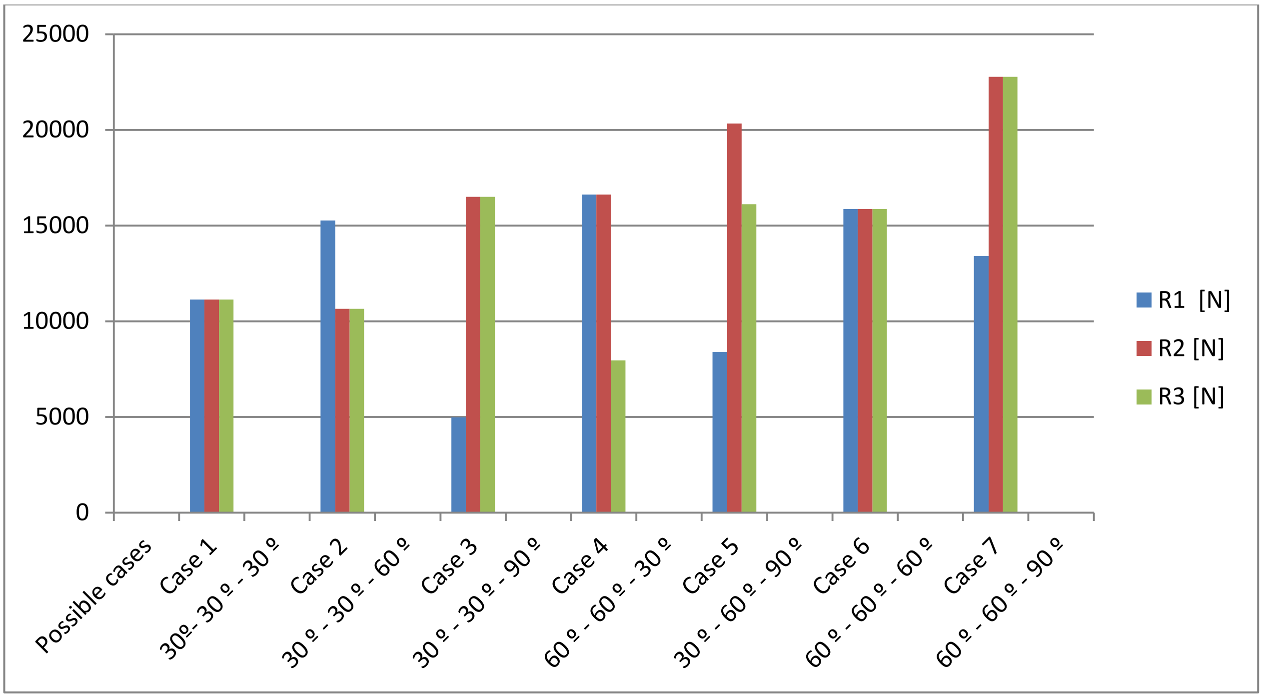

Figure 8. View results.

For a better visualization of the results given in Table 1. the graphic presented in Figure 8. was realized.

Analysing the results in Table 1, we can say that the greatest force distributed over a foot, is in the 7th case (22763N) when a leg of the tripod is positioned at 90º and the other two at 60º, resulting in the most unfavourable work situation.

The minimum value of the force distributed on a foot 4977 N (case 3), is reached when a tripod leg is positioned 90º with the axis of symmetry and the other two at 30º (Figure 8).

If all tripod legs are positioned at 30º or 60º to the axis of symmetry, the force is equally distributed on each foot ($R_1 = R_2 = R_3$), respectively 11140N or 15869N.

4 CONCLUDING REMARKS

Due to the double stabilization, upper and lower level, tripod redesigned to those on the market has the following advantages: speed in assembly, stability, high strength, ergonomics, versatility, ease of transport and storage.

Positioning the tripod on rough and uneven surfaces, is allowed by the rotation to the desired angle and telescopic movement of its components.

Complex tripod for rescuing from different backgrounds is an accessory to rescue people and animals either as separate accessory or using it with other accessories and equipment of special vehicles (ropes, pulleys, carabiners, winch, stretchers, harness etc).

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7 NOTATION

The following symbols are used in this paper:

c- safety factor;

CAD -Computer Aided Design;

Creo- design software;

D-outer diameter;

d-internal diameter;

ECAD-Electronic Computer Aided Design;

F-Force;

h-height;

Kg-Kilogram;

MCAD-Mechanical Computer Aided Design;

mm-millimeter

N- Newton;

PTC Inc- Parametric Technology Corporation;

R- force component;

R1, force component on the leg 1;

R2- force component on the leg 2;

R3- force component on the leg 3.