SERVICE BULLETIN

REINFORCEMENT TO NOSE LANDING GEAR SHOCK ABSORBED TYPE MANUFACTURED BY IBIS Aircraft S.A.

May 19th 2009.

SB-Ibis-009

INFORMATIVE

AFFECTED AIRCRAFT:

All aircraft IBIS type (Magic, Urraco, Millenium), that have the nose- landing gear system shock absorbed type, with production date prior to the month of May 2009.

REASON:

It was detected that in abnormal operating situations, in Landings and/or taxiing, the landing gear shock absorbed type tends to have a failure that could make it brake due to the great stress found, such as, batches and/or holes in the landing field, non aligned landings, abrupt landings, abnormal landings forcing the nose landing gear. This causes the fault in the piece that eventually makes it fracture.

In normal operations, the current Nose Landing Gear Auto-Shock absorbed type does not present any conditions that make the piece fail. In order to verify this, a structural analysis of the landing gear was realized, See Annex 1.

Due to the demand of a more resistant landing gear to abnormal operations, the company decided reinforce the structure based in the analysis presented in Annex 2 where the results of the modification presented in this bulletin is shown and the analysis of the reinforcement that the manufacturing plant Hill make as of this date.

SUBJECT:

In order for the Nose Landing Gear Auto-Shock absorbed type to show greater safety in abnormal operation situations, a modification should be made, this operation consists on installing a reinforcement in the Nose Landing Gear Auto-Shock absorbed type in order to create a higher resistance in the in the piece for these abnormal operation situations where a larger effort and resistance is demanded from the Nose Landing gear..

COMPLIANCE:

On the user's consideration as of this date.

EXECUTION / INSTRUCTIONS:

EXECUTION. By IBIS Aircraft S.A, production plant, Service Centers and Distribution Centers.

INSTRUCTIONS. To reinforce the Nose gear Auto-Shock absorbed type, a reinforcement should be installed in the rear part of the gear. (Figure 1).

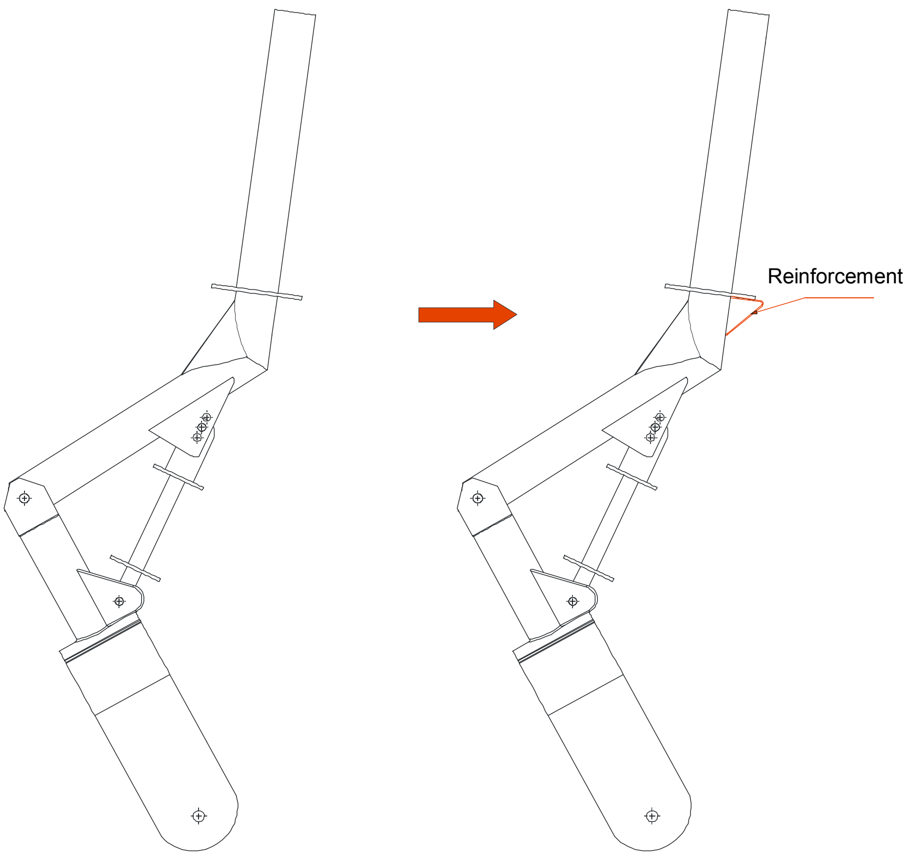


Figure 1

The reinforcement should be made of Normalized Cromomolibdeno steel 4130 3,175mm, (1/8") thick. The approximate dimensions are presented alter; these dimensions are for reference since the important thing is to install the reinforcement. (Figure 2).

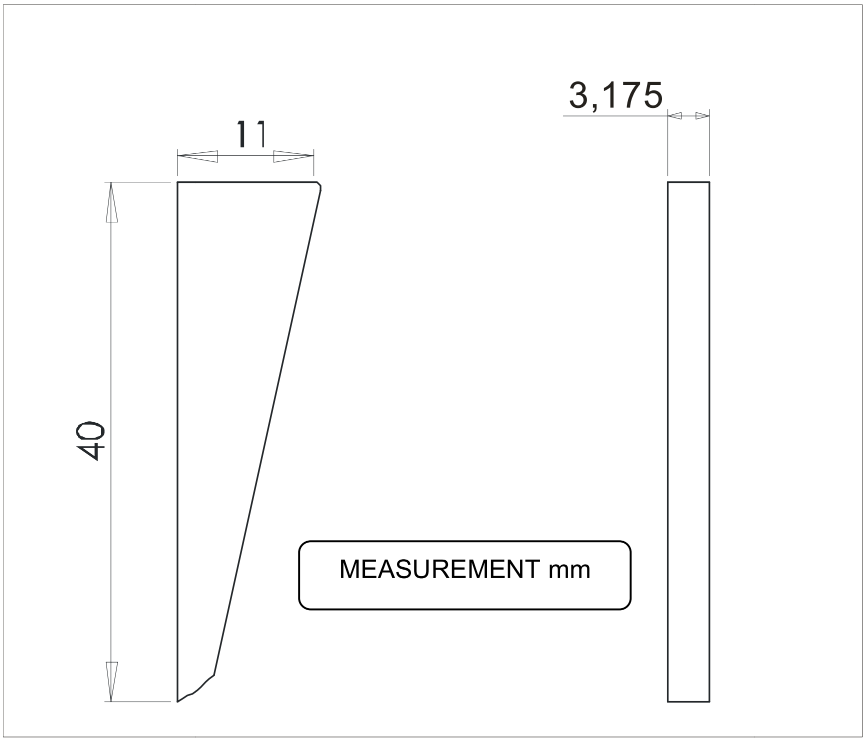


Figure 2

This reinforcement should be welded in the rear part of the landing gear, aligned and centered to the nose gear's pipe where this piece is located. (Figures 3 and 4).

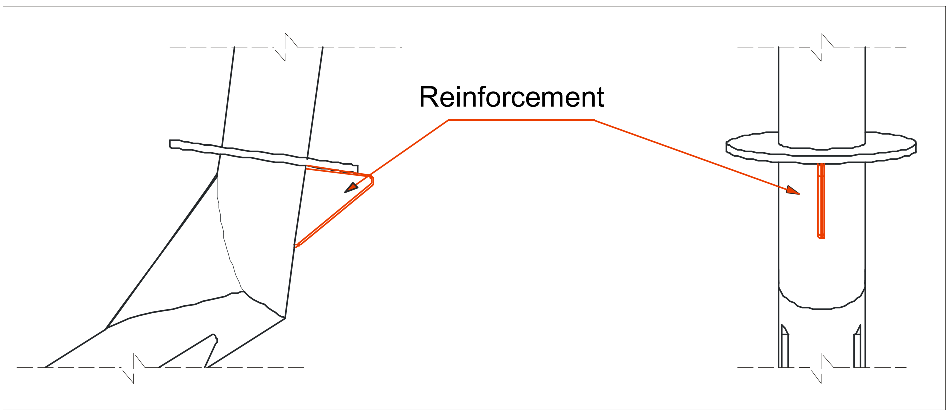


Figure 3

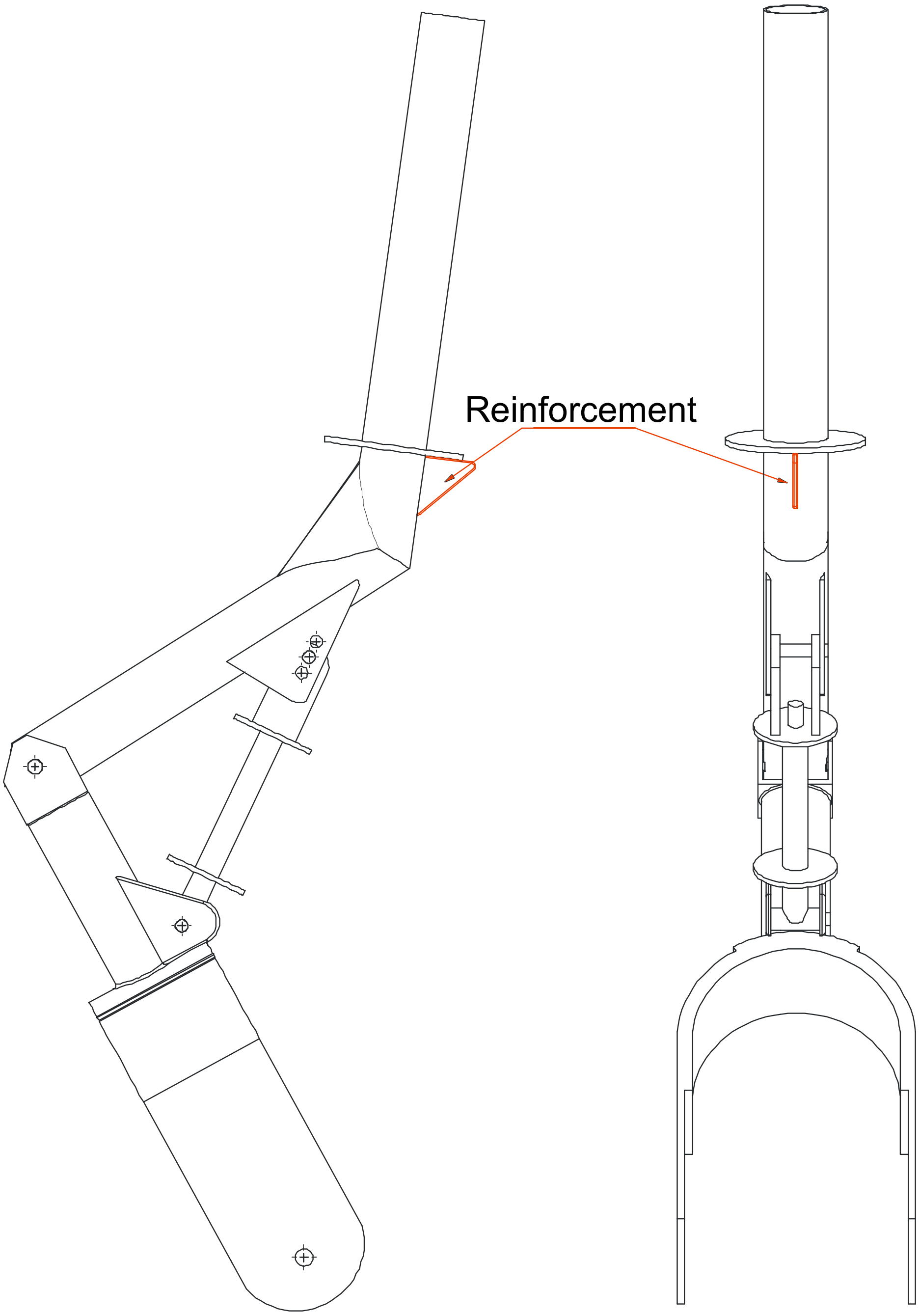


Figure 4

With this modification the nose landing gear auto shock absorbed type will have better resistance and safety in abnormal operation situations, besides, as of this date, IBIS Aircraft S.A's production plant besides realizing the external reinforcement, will reinforce the gear's pipe internally in all the pieces manufactured from now on, guaranteeing the piece's resistance in these highly demanding situations. (Figure 5).

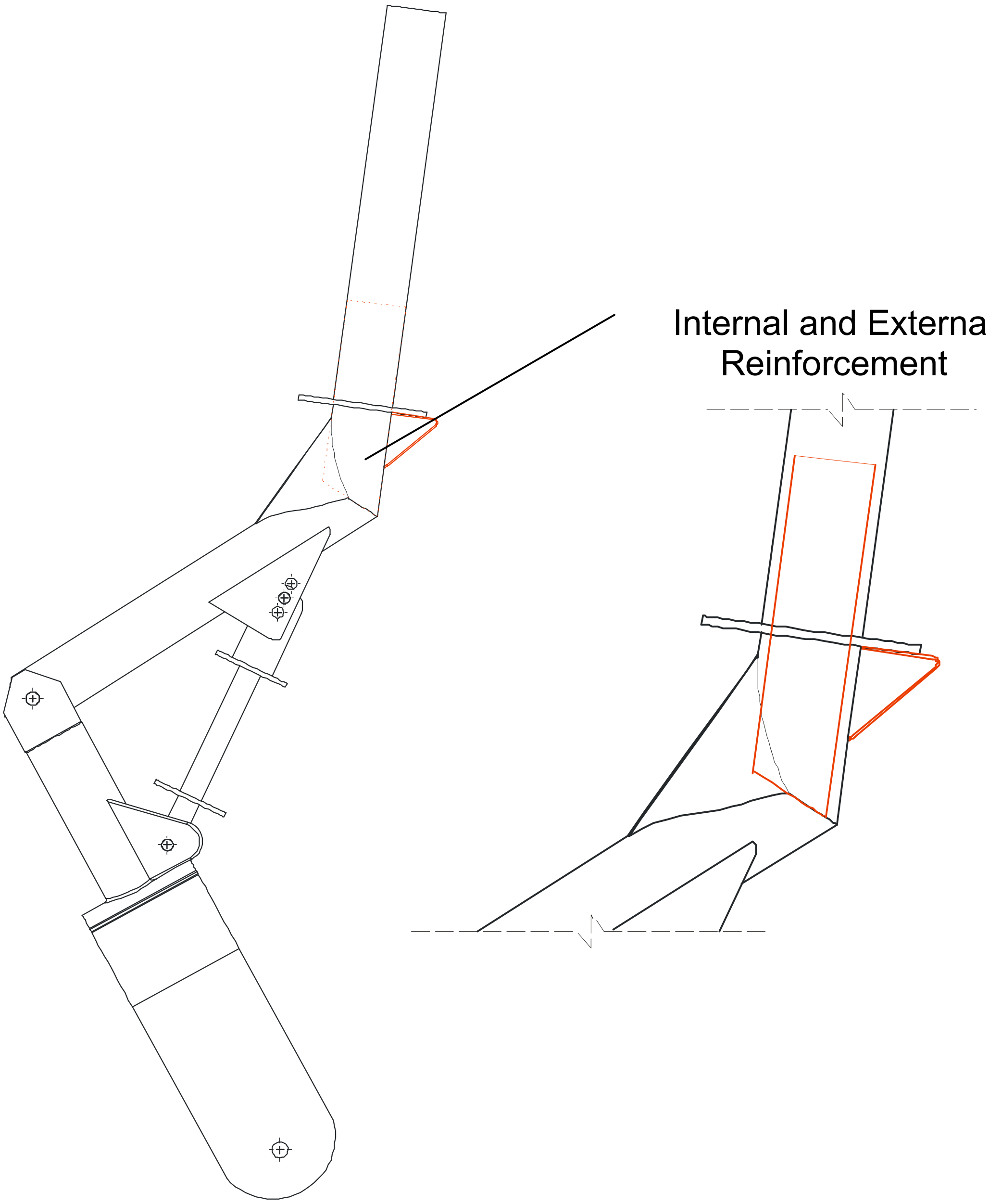


Figure 5

ANNEX 1

STRUCTURAL ANALYSIS OF THE NOSE LANDING GEAR AUTO SHOCK ABSORBED TYPE

OBJETIVE

This work consists on analyzing the Nose Landing Gear of the MAGIC GS-700 Aircraft, of the different cargo cases to which is submitted to during its operation, therefore, a virtual model was realized in order to determine the most critical zones where the mayor stress that can cause damages to this piece ore even brake it

1. INTRODUCTION

The objective of this work is to analyze the MAGIC GS 700 Aircraft's nose landing gear's structure built in a steel Molybdenum Chrome 4130 alloy normalized, based in a virtual model analyzed through the finite element method

This work is very important for IBIS AIRCRAFT S.A., since it allows it to guarantee its customers and excellent performance of the piece during its useful life

2. METHODOLOGY

In the first stage of the structural analysis, a virtual model of the nose landing gear was made through a – CAD - software in order to realize the appropriate study of the different cases of static charge to which the structure is submitted to during its life span. The cases studied for this structural analysis are:

- *When the aircraft is not in movement.*
- *During the maximum brake demand.*
- *In a landing with inclined reactions.*
- *During the taxiing on an irregular terrain, (Landing field not prepared).*

There should be excessive loads. The maximum stress generated in each one of these cases that could cause the fracture of the nose landing gear should be analyzed further on through the finite element method (FEM)

3. DEVELOPMENT AND RESULTS

For the structural analysis of the nose landing gear in the different cases that were presented before the following is realized:

a) A model of the nose landing gear was made through a CAD. (Figure 1A).

Figure 1A

b) The maximum stress generated in the structure is analyzed through finite elements in order to see possible failures, taking into consideration the following aspects:

- To get the best results in the analysis of the structure of the nose landing gear the loads are applied directly into the holes that support the axel of the tire, in order to guarantee what load can take until it exceeds the material limit leading it to its fracture. Otherwise it should be taken into account some considerations such as:
  - Increasing the inflation pressure in the tire contact area with the landing field will be reduced by increasing the load per unit area transmitted to it.
  - The contact area of the tires with the landing field is inversely proportional to the inflation pressure, ie the braking is more difficult when using a high inflation pressure.

- It is an isotropic material and a steel Cromolibdeno 4130 Normalized with the following characteristics (Table 1):

Elasticity Module E		**Rigidity Module G**		**Reason Position V**	**Mass Density p**	**Elastic Limit to Tension**		**Maximum Resistance to Tension**		**Elongation in 2"**
Mpsi	*GPa*	*Mpsi*	*GPa*	0,28	*Mg/m³*	*Kpsi*	*MPa*	*Kpsi*	*MPa*	*%*
30	206,8	11,7	80,8		7,8	63	434	97	669	25

Table 1

CALCULATION OF THE SITUATIONS

WHEN THE AIRCRAFT IS STATIC.

In this case the aircraft does not perform any type of movement. (Figure 2A).

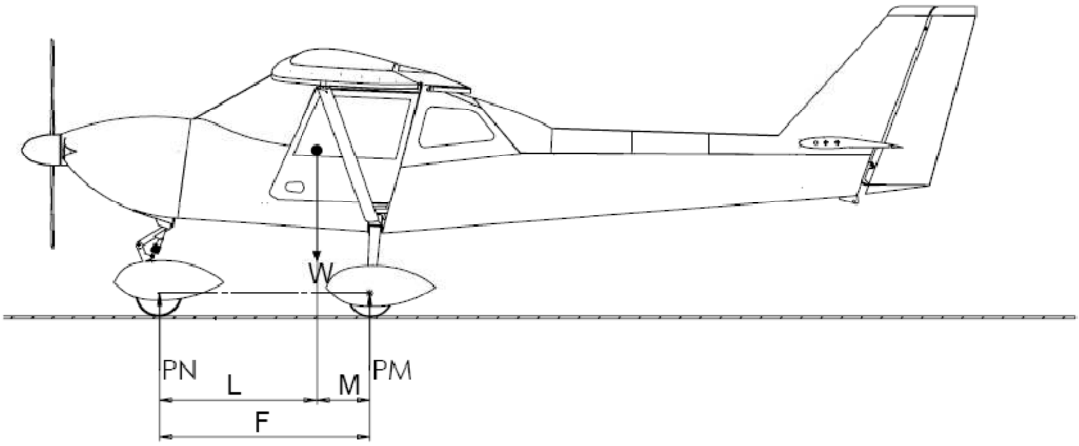


Figure 2A

The loads acting on the nose landing gear of the aircraft shown in Figure 2A depend on an analysis of static equilibrium.

$\overline{}$

Where:

L	=	distance in x from the CG to the nose landing gear
M	=	distance in x from the CG to the main landing gear
W	=	maximum weight of the aircraft
	=	load that acts on the nose landing gear
Pm	=	load that acts on the main landing gear

For:

L	=	1060	mm
M	=	290	mm
W	=	590	Kg

We'll have that:

= 127 kg

By applying the load on the structure of the nose landing gear (Figure 3A) and analyzed where the maximum stress σ_{max} is generated in the structure (Figure 4A), i.e. the most critical area where the piece tends to fail, we note that for this load a maximum stress σ_{max} is not generated that exceeds the yield strength σ_y of the material and get a reliable safety factor (Figure 5A).

σ_{max}	≤	$\sigma_{admissible}$	$\sigma_{admissible}$	=	
σ_{max}	=	148,28 MPa	σ_y	=	434 MPa

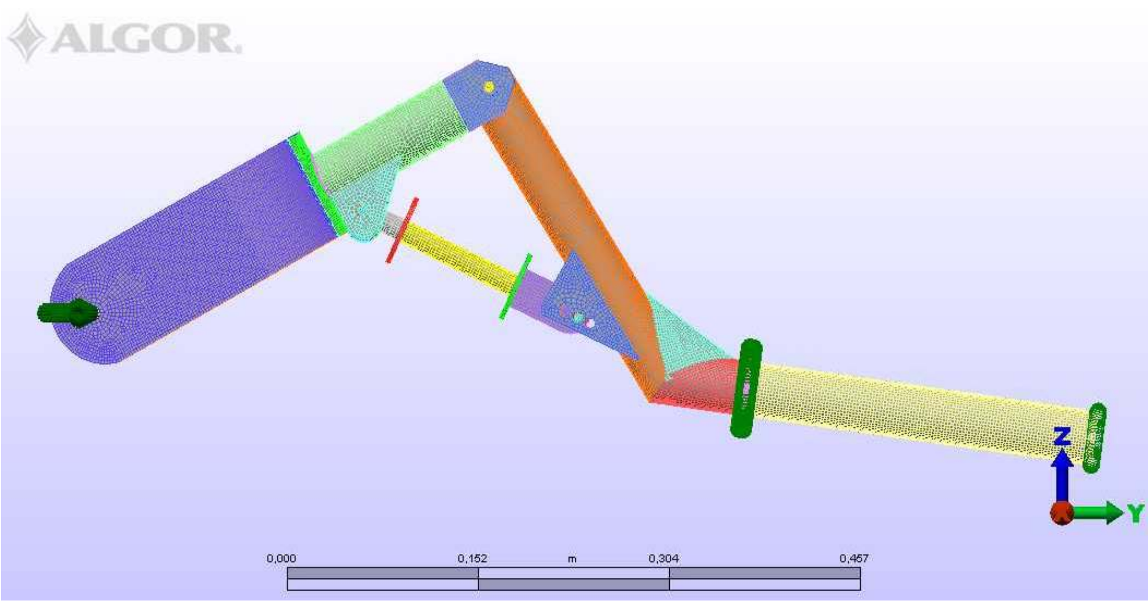


Figure 3A

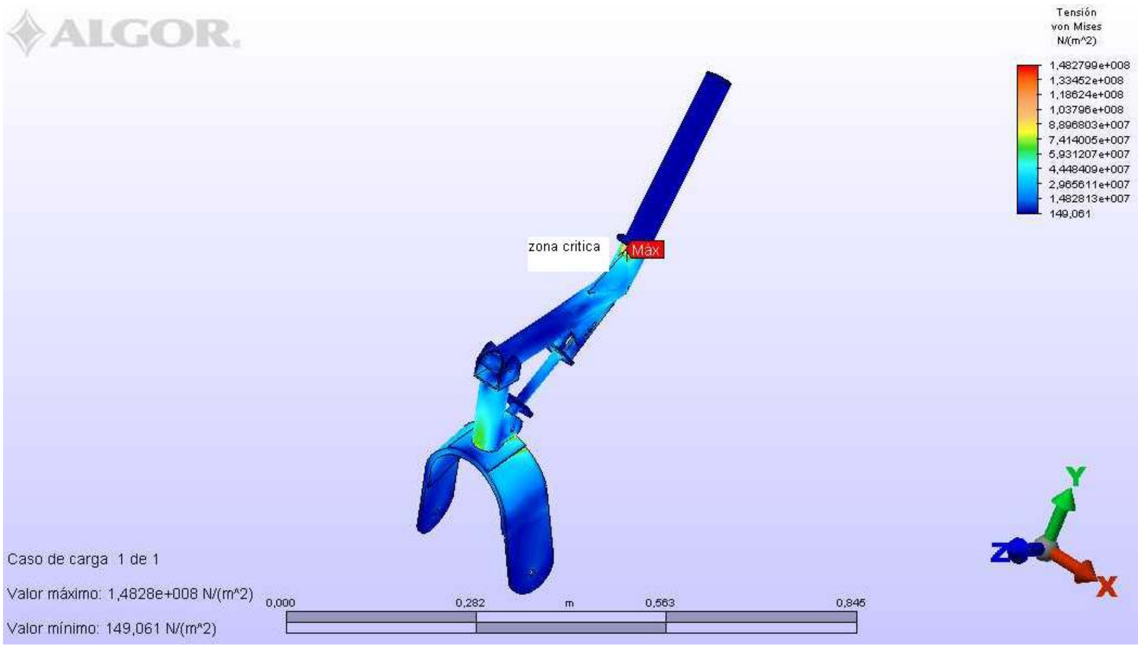


Figure 4A

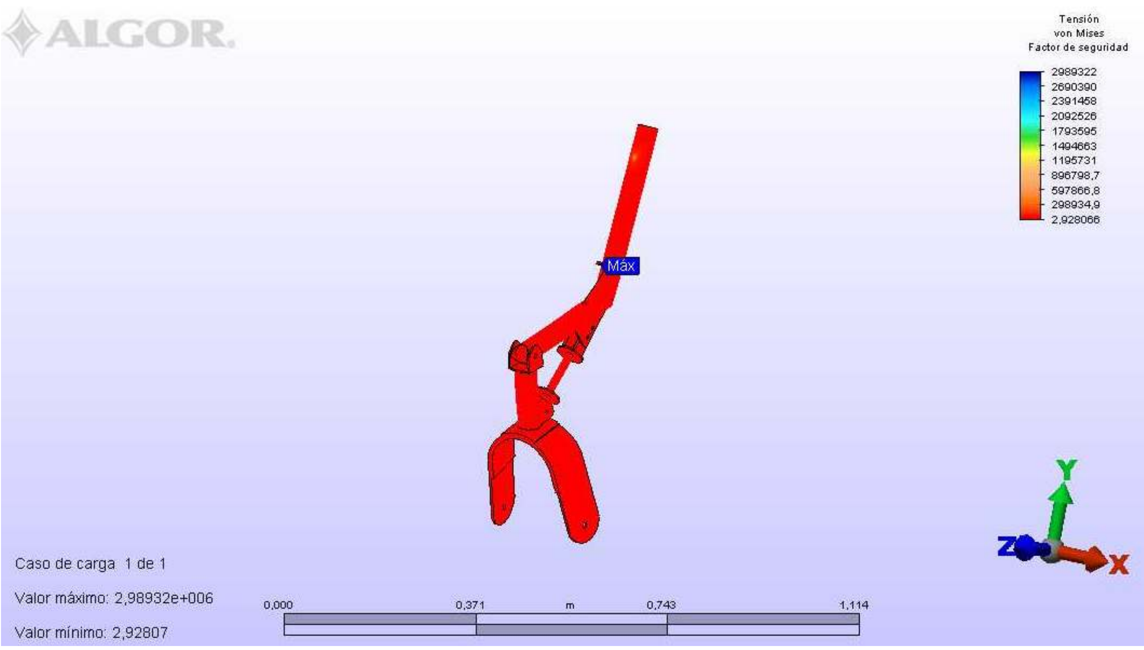


Figure 5A

MAXIMUM BRAKING DEMAND

To determine the charges to be borne by the nose landing gear during maximum braking requirement (Figure 6A), aerodynamic moments are considered invalid, the nose wheel without brakes and a deceleration of 10ft / s^2.

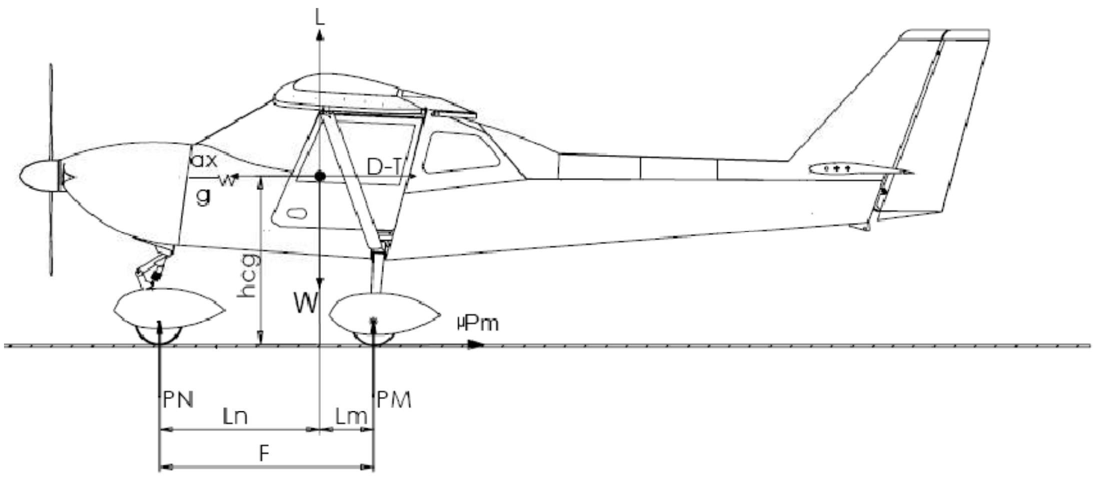


Figure 6A

Developing a static equilibrium we have that:

— (1)

— (2)

(3)

(4)

The load on the nose wheel is:

— — — — — — (5)

The greatest burden on the train nose during braking is when T = 0 then we have:

Braking load on the nose landing gear = Maximum static load

For J= 1200mm

Maximum breaking load in the nose landing gear = 290 kg

By applying the load = 290 kg in the structure of the nose landing gear generates a maximum effort σ_{max} = 338 Mpa (Figure 7A) in the most critical zone we notice that for this load a maximum effort σ_{max} that exceeds the yield strength σ_y is not generated and a safety factor Fs = 1,28 (Figure 8A).

$\sigma_{max} \leq \sigma_{admissible}$ $\qquad$ $\sigma_{admissible}$ =

σ_{max} = 338 MPa $\qquad$ σ_y = 434 MPa

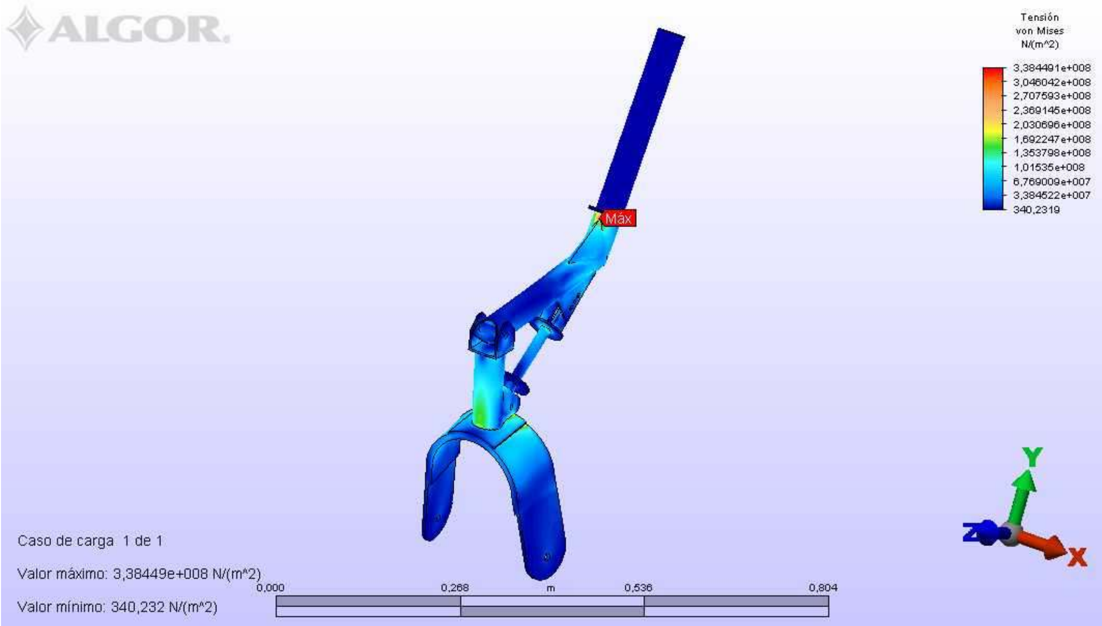


Figure 7A

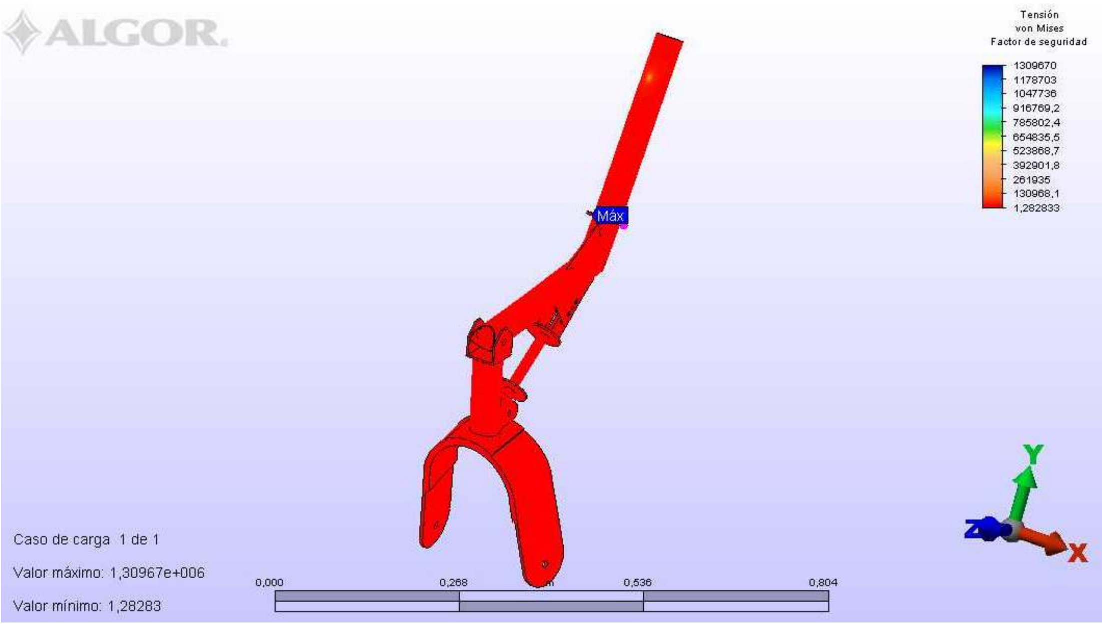


Figure 8A

LANDING LEVEL WITH INCLINED REACTIONS

According to the basic landing conditions laid down by the *FAR 23*, the level of inclined landing reactions will be studied, that is where the nose wheel and main wheels are touching the ground simultaneously, since it is here that the structure of the nose landing gear will be subject to horizontal and vertical loads. (Figure 10A).

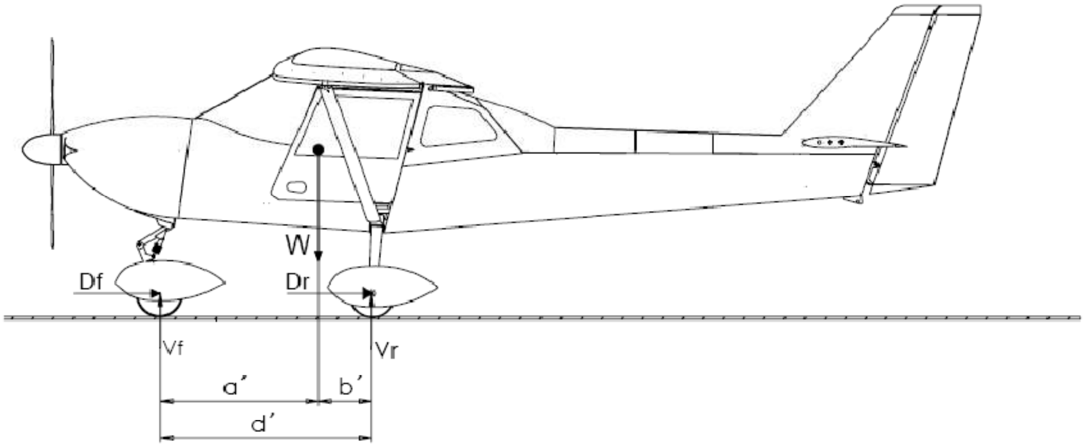


Figure 9A

The vertical loads *Vf* and horizontal loads *Df* acting on the nose landing gear are:

– –

Where:

a´	=	distance from the CG to the nose landing gear
b´	=	distance in X from the CG to the main landing gear
W	=	peso aircraft's maximum weight
Vf	=	vertical load acting on the nose landing gear
Df	=	horizontal load acting on the nose landing gear
n	=	limit of inertia load factor
L	=	ratio of the lift for the weight of the aircraft (not less than 0,667)
K	=	0,25 for aircraft of W= 3000 pounds or less

For:

a´	=	1060mm	
b´	=	290mm	
W	=	590Kg	
n	=	3,0	(not less than 2,67 suggested by *FAR 23*)

We'll have that the vertical load and the horizontal load are:

= 295Kg = 95Kg

Fort he load *Vf* = 295 kg and *Df* = 95 kg to the structure of the nose landing gear a maximum effort σ_{max} = 407Mpa is generated (Figure 10A) in the most critical zone and a safety factor Fs = 1.066 is obtained (Figure 11A).

$\sigma_{max} \leq \sigma_{admissible}$ $\sigma_{admissible}$ =

σ_{max} = 407 MPa σ_y = 434 MPa

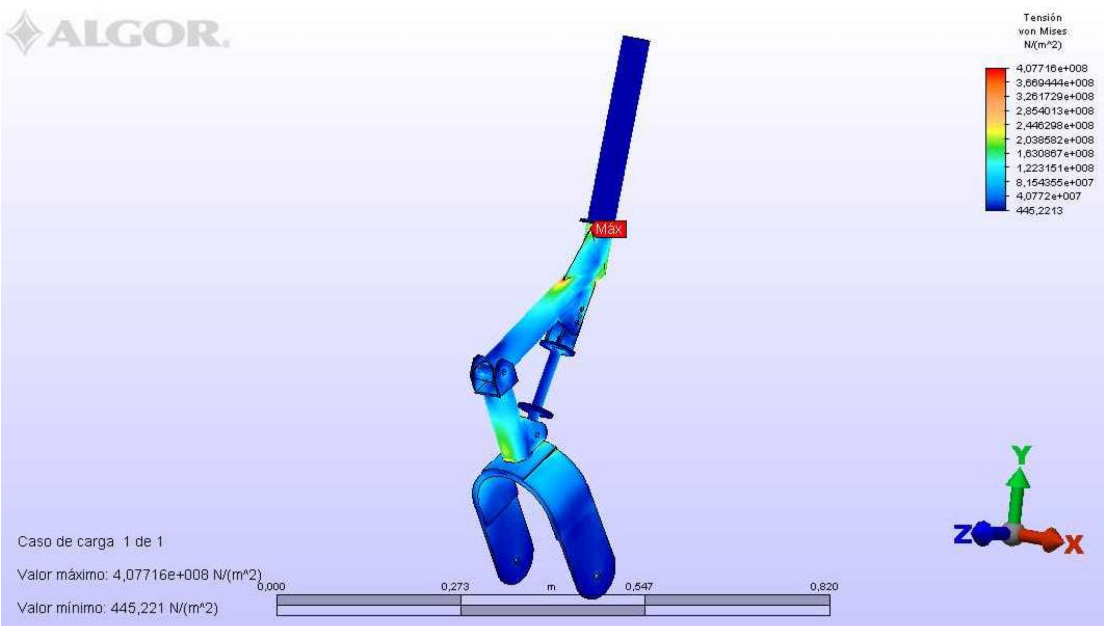


Figure 10A

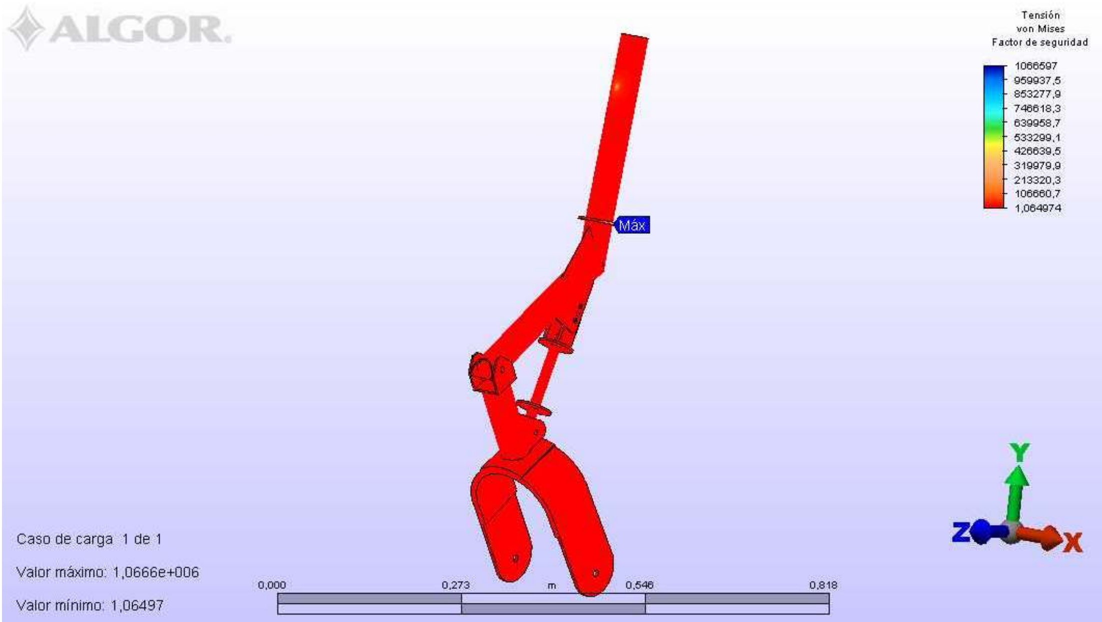


Figure 11A

TAXIING ON AN IRREGULAR TERRAIN

In this case we'll study when the aircraft is taxiing on an uneven terrain and front vertical loads are generated by either the poor state of the ground or an obstacle on the landing field. Given that the aircraft taxis at low speed

Performing a static equilibrium of Figure 6A we obtained the equation (4), of the position of maximum braking application, that for the object of analysis we will retake again:

For:

Lm	=	290mm
Pm	=	463Kg
Ln	=	1060mm
μ	=	0,05 for low grass

We have that:

= 153Kg

Knowing the vertical load = 153 Kg (Figure 12A) that acts on the tire we proceed to apply the front loads *Pf* (Figure 12A) in order to meet the necessary load to obtain the maximum stress σ_{max} that causes the fracture of the structure (Figures 13A , 14A, 15A).

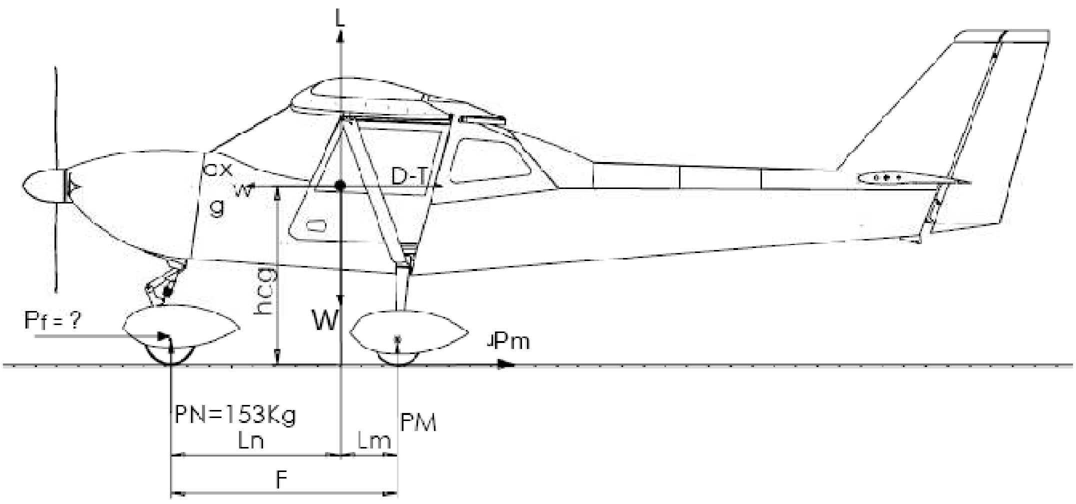


Figure 12A

Applying a load = 153Kg and *Pf* = 70Kg (Figure 13) Applying a load σ_{max} = 369 Mpa is obtained (Figure 14A) and a safety factor Fs = 1,17 (Figure 15A).

$\sigma_{max} \leq \sigma_{admissible}$ $\sigma_{admissible}$ =

σ_{max} = 369 MPa σ_y = 434 MPa

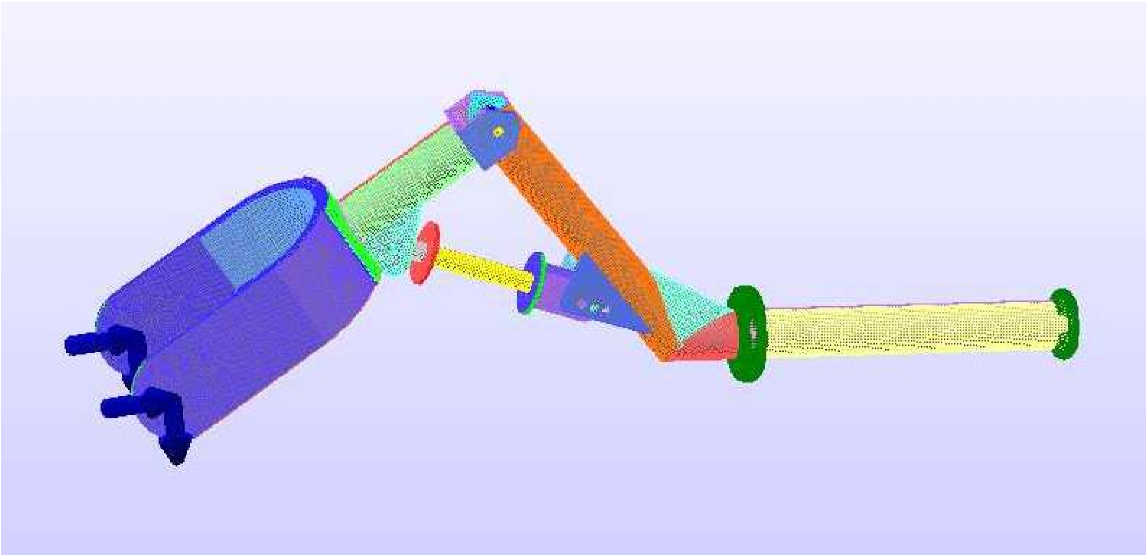


Figure 13A

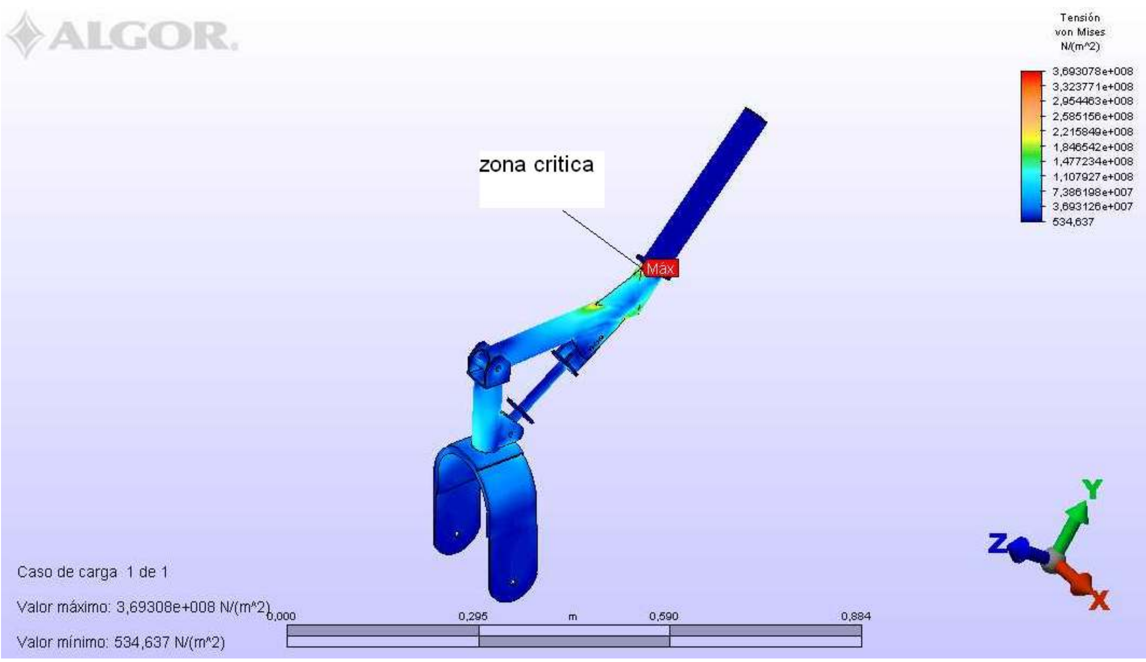


Figure 14A

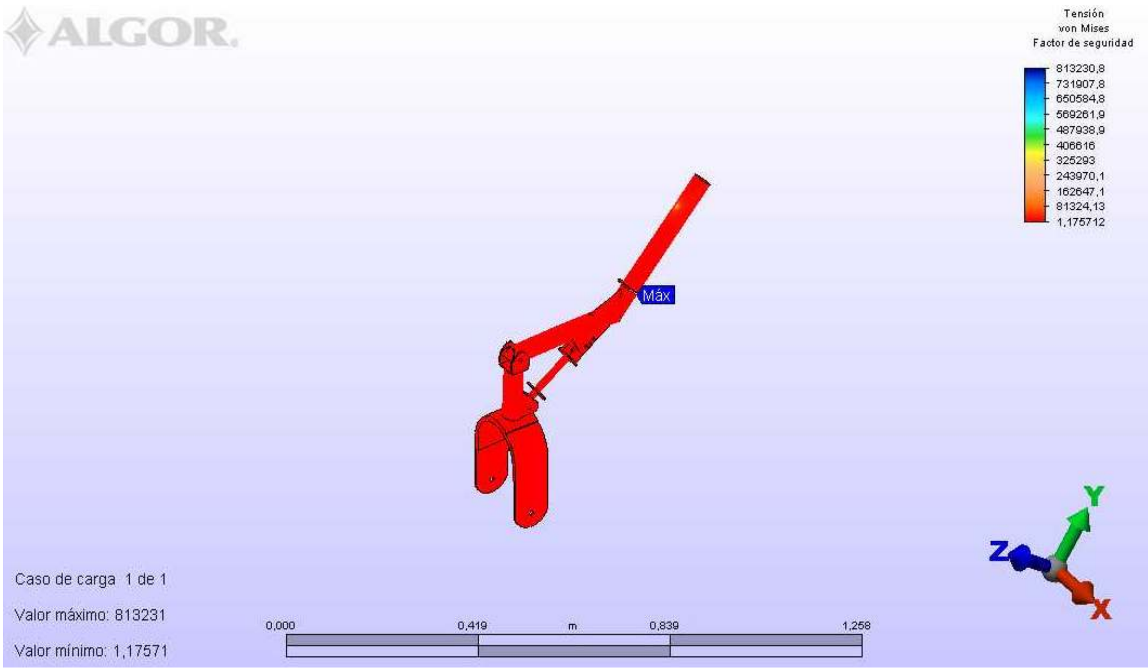


Figure 15A

ANALYSIS OF SITUATIONS

CASE 1: ***IF THE AIRCRAFT IS STATIC.***

For the case where the aircraft is completely static maximum stress σ_{max} = 148,3MPa generated in this analysis due to the load acting on the structure of the nose landing gear does not exceed the yield strength σ_y = 434MPa of the material and having a factor Security Fs = 2.9, therefore it will not cause the fracture of the piece.

CASE 2: ***MAXIMUM BRAKING DEMAND.***

In the case for the most braking demand of the aircraft where the maximum stress σ_{max} = 338MPa and having a yield strength of the material σ_y = 434MPa a safety factor Fs = 1.2 is obtained which would not cause the structure to reach its rupture point, but if it is recommended after this to check it completely, since it is not a normal situation under these characteristics.

CASE 3: ***LANDING LEVEL WITH INCLINED REACTIONS.***

At the landing level with inclined reactions due to the maximum stress σ_{max} t is so close to the yield strength of the material and presenting a safety factor Fs=1,0 the structure of the nose landing gear would have reached its breaking point, this is a critical situation where the failure of the structure would happen.

CASE 4: ***TAXIING ON IRREGULAR TERRAIN***

During the taxiing on an uneven terrain at low speed it is unlikely that the landing gear fails, it's necessary an additional burden on the ground, obstacle or batch of 70kg at the moment of taxiing in order for the nose landing gear's structure to fracture.

As the aircraft gains speed it will be needed less of a front - load or radial load in order for the structure to fail, due to the maximum stress σ_{max} will increase in the operation.

With the analysis and study of previous cases, we show that the Nose landing gear Auto shock absorbed Type manufactured by IBIS Aircraft SA requires abnormal - situations to report a failure, based on this analysis, the company will implement to its new landing gears some reinforcements in the structure of the piece to ensure and guarantee the strength of the landing gear in more demanding abnormal operations.

ANNEX 2

STRUCTURAL ANALYSIS OF NOSE LANDING GEAR SHOCK ABSORBED TYPE - INSTALLED REINFORCEMENT

The object of study was based on 3 situations for which comparing points were obtained, the first study was to analyze the nose landing gear before any change in the second study the nose landing gear was analyzed with the rear triangular external reinforcement and the third study analyzed the nose landing gear with its external reinforcement and additional internal reinforcement. front-loading was applied to each of the models tested, to the point of fracture of the structure of the nose landing gear. (Figure 1B and 2B)

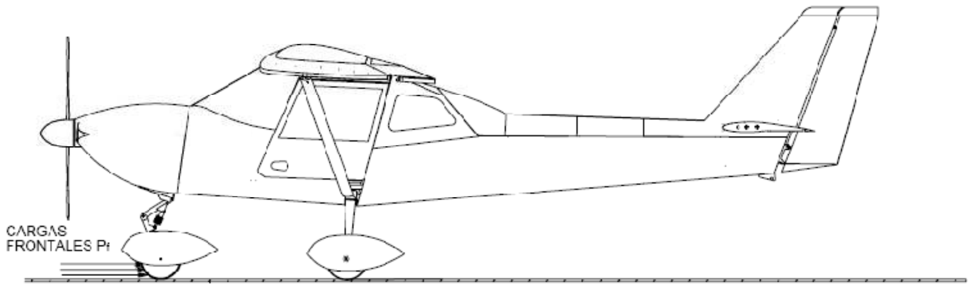


Figure 1B

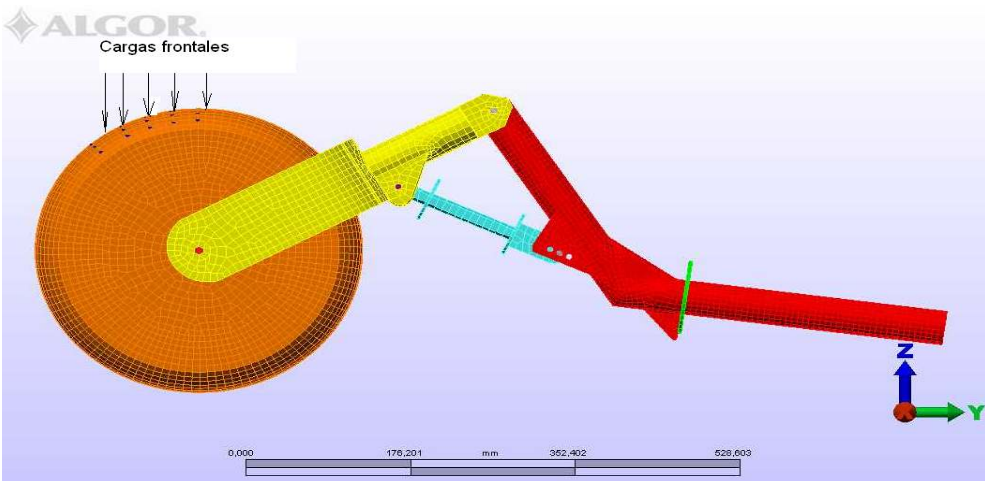
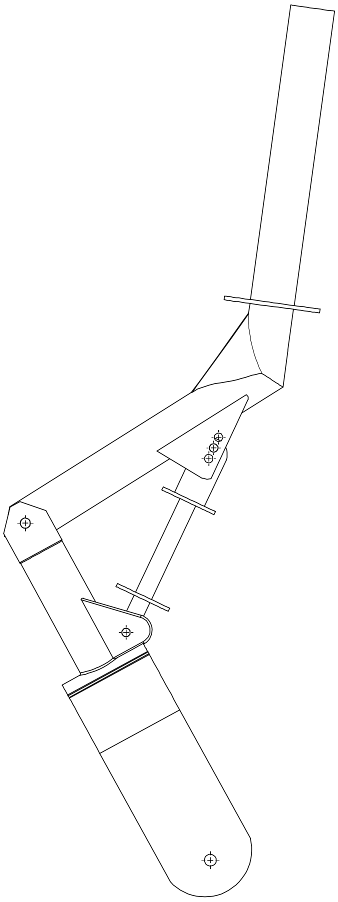


Figure 2B

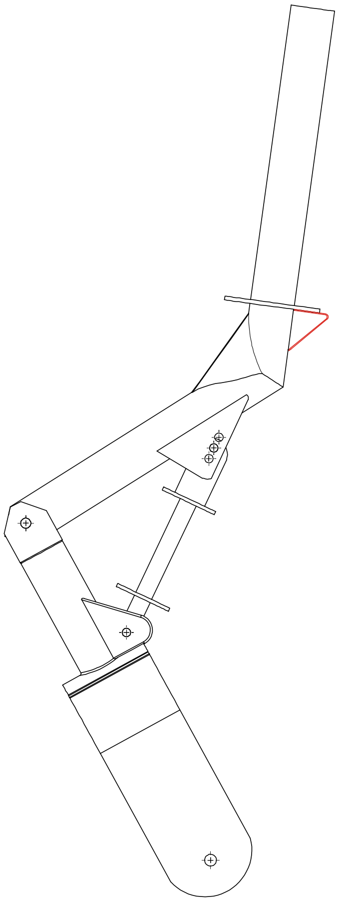
MODEL 1, Nose landing gear Auto-shock absorbed type without any reinforcement, manufactured prior to the date. (Figure 3B).

MODEL 2, Nose landing gear Auto-shock absorbed type, with the triangular external reinforcement. (Figure 4B).

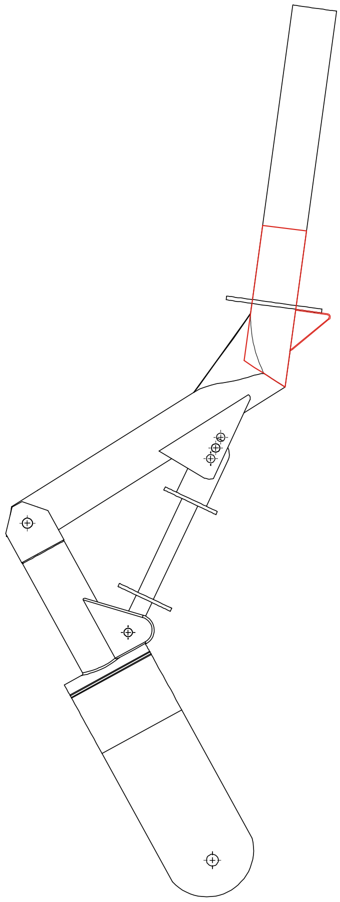
MODEL 3, Nose landing gear Auto-shock absorbed type, with the reinforced triangular external and the internal reinforcement. (Figure 5B)



Model 1
Figure 3B



Model 2
Figure 4B



Model 3
Figure 5B

The results of the analysis are presented in the table below, these results look for the breaking point with the maximum load to get to this point. (Table 1B)

The results are obtained based on the program Algor and the formulas that lead to these results.

Model	**Flowing stress σ_y**	**Maximum stress σ_{max}**	**Security Factor** Fs	**Rupture Load** $P_{Rupture}$
Model 1	434 Mpa	420 Mpa	1,0	441 N
Model 2	434 Mpa	425 Mpa	1,02	539 N
Model 3	434 Mpa	443 Mpa	0,98	686 N

Table 1B

Analysis of Each Model

1. The structure of *Model1* fractures under a load of 441N in which there is a maximum effort σ_{max} = 420MPa up to the yield strength of the material.

2. The structure of *Model 2* supported a 22.22% increase of load than the structure of Model 1, needing a maximum load of 539N to reach the fracture point

3. The structure of *Model 3* supported a 55.6% more load than the structure of *Model 1*, needing a maximum load of 686N to reach the point of fracture.

In this way we ensure that the structure of the nose landing gear in each of the analyzed situations may have a greater resistance in abnormal operations in relation to the original piece without any reinforcement, thus allowing a much greater margin of slack in situations requiring more stress from the structure.