Full suspension MTB frame

034353/4- New Product Design

Customer
Segal Bikes LTD

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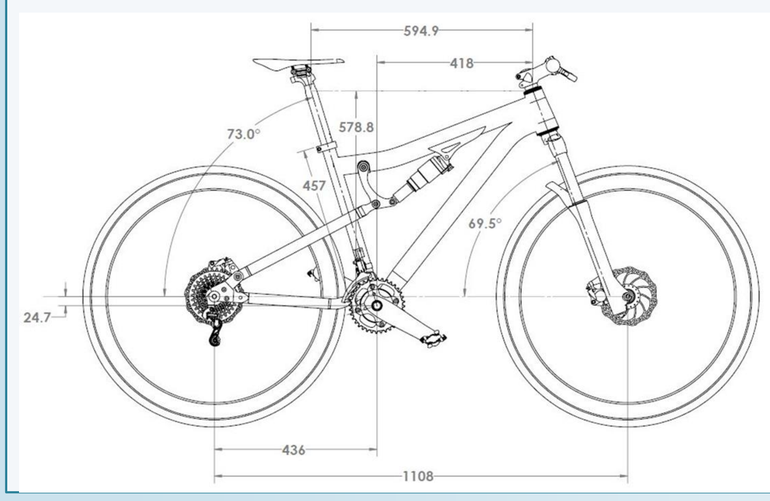
Project Advisor
Mr. Shahar Millis

Frame Main Features & Geometry

- Components were carefully chosen to maximize stiffness to weight ratio such as 12X142 Rear Axle & Tapered Head Tube, Internal cable routing was added for stealth looks and durability.
- Geometry was optimized for both comfort and efficiency : Minimal CS length for maneuverability, mid values for HA, Wheel base, Reach & stack.



Weight (Frame only)	3Kg
Rear wheel travel (mm)	103
Wheel size	27.5
Top Tube eff. Length (mm)	594.9
Head Tube Angle (deg)	69.5
Seat Tube Angle (deg)	73
Wheelbase (mm)	1108
Chainstay Length (mm)	436
BB Drop (mm)	-24.7
Reach (mm)	418
Stack (mm)	578.8

Production

Manufacturing took place in Alubin/Segal bikes workshop, although Segal Bikes already have their own welding Jigs, New custom Jigs were made for the rear triangle, and for the CNC parts implemented in the front triangle. (See Pics below)

The frame is made from Mg profiles that were chosen from Segal catalog, some of the tubes were bended as seen below.
All the CNC parts implemented in the frame are a unique design that was made by the team.
Aluminum is harder than Mg so we can create improved reliability in bearing houses and such. For that reason we used Aluminum 6061 T6 & 7075 T5 in the rocker link and pivots parts.

Thanks

We would like to thank the people that made this project happen:

Gal Segal , Itay Groag , Ofir Sharon , Alexy Mahrakov, Roman Zarobinsky and the rest of Alubin plant workers that believed in us and gave us free hand to fulfill our wishes in this project.

To our project advisor Mr. Shahar Millis who shared his knowledge and wisdom with us and kindly hosted us in his house.

Kind people along the way that helped and advised: Pr. Morel Gruper, Pr. Doron Shilo, Gil Benita & Moran Shir from bikedeal.co.il, Amit Aknin, Gidi Groag from SKF Israel, Tuval Roth from Disshouse, Maor Aharon, Saar Galvan, Alon Chefer from Fox racing shocks, Felix Baron, Danziger Lab workers, Gergely Kovacs from linkage.

Brief

Segal Bikes is an Israeli bike Manufacturer known for it's Magnesium road & hardtail bike frames.
This project's goal is to build the first full suspension bike designed & built in Israel.
Mountain biking Is a rapidly expanding sport. As a result, the demand for a larger verity of models is growing as well, Segal frames differ from most manufacturers by being made from Magnesium Alloy as opposed to Aluminum or carbon fibers.
The challenge was to create a frame that is pedal efficient, light weight, reliable, comfortable and attractive.

Customer requirement & Project targets

The main requirement was to create a Cross Country/Trail bike with 100mm of travel and 27.5 Inch wheels. A requirement that meets the latest technology trend on the market.
The following attributes were highly desired:

1. Frame efficiency : Minimizing Bobing effect (Anti Squat) & Lateral stiffness.
2. Progressive Force/Travel graph for the desired suspension feel.
3. Simple & feasible design due to the project time limit.
4. Attractive & Market oriented design.

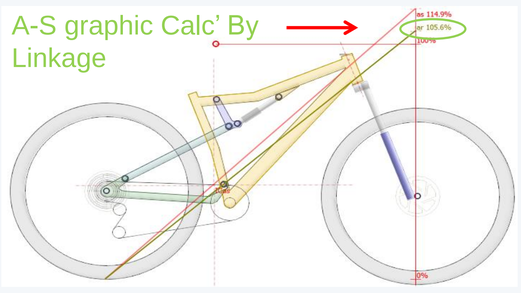
Challenges

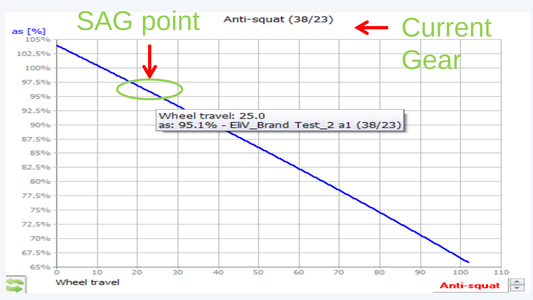
- A mountain bike is a special product in the sense that a lot of it's functions are based on the rider's feeling rather than a tangible measurement that can be quantified or measured. The first challenge was to translate the customer's requirements into specific attributes and parameters to incorporate in the design.
- Understanding the trade-offs of the geometry & linkage was also a challenge. Linkage X3 software was used to analyze & choose the linkage design.
- Pivot design required an understanding of bearings and other pivot parts .After consulting SKF Israel, the custom made 7075 Aluminum pivots were designed. The chosen bearings are standard sealed ball bearings for easy replacement.

Linkage & Pivots design

The first element of a full suspension bike is the linkage design which affect pedal efficiency ,shock absorbance , braking effects and the responsiveness of the bike.
Popular suspension systems were reviewed, and the four bar linkage mechanism called "single pivot link" was chosen . This choice of linkage addresses our main issue ,which is efficiency, without compromising other parameters. This linkage is also relatively simple and prone to changes in the final prototypes .Linkage X3 professional software was used to get the linkage performance that we aimed for.

Anti Squat (Bobing):
One of the major issues with full suspension bike is the rear shock compression and extension effects caused by pedaling and not due to forces from the ground. We designed the linkage to neutralize these effects by using the effect of weight transfer and chain force. The amount of such neutralizing effect is called Anti Squat, when 100% Anti squat refers to no effect due to pedaling.

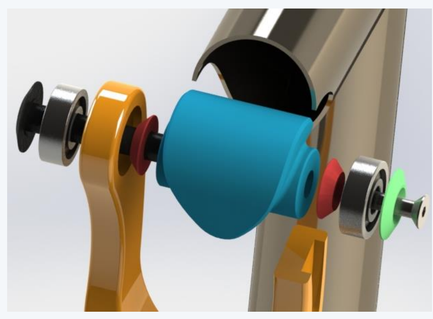




Pivots design:
A riding load profile was created in order to calculate pivots and bearing safety factors:

$$D = \Sigma \frac{n_i}{N_i} = \frac{6.5 \cdot 10^6}{6.5 \cdot 10^9} + \frac{8.9 \cdot 10^5}{2.6 \cdot 10^8} + \frac{3.7 \cdot 10^4}{8.9 \cdot 10^7} \approx 0.005 < 1 \rightarrow OK!$$

$$n_d = \left(\frac{\sigma_a}{S_{N1}} + \frac{\sigma_m}{S_{ut}}\right)^{-1} = \left(\frac{69.63}{276.93} + \frac{129.3}{570}\right)^{-1} = 1.97$$



Progressive Force/Travel Graph:
In order to create the desired progressiveness we had to learn the shock inherent graph and then apply the right Linkage geometry so the overall graph will ramp at the end of the travel.
The graph on the right is the result of this effort.
To Learn the shock curve a press experiment was conducted at the Danziger Labs (Technion). This experiment revealed the shocks curve along with the maximum shock force so we could calculate forces in the frame from it.