Student Name: Ciaran Skinner

Student Number: 1801833

Course: Automotive Design

Module Name: Materials and Manufacturing

Module Code: ADDA4001

Tutor’s Name: Andre Elista

Word Count: 1500 words

Materials & Manufacturing

The product that I have chosen for this brief is the dual suspension mountain bike frame with the aim to redesign the frame for a light endurance motorbike. The frame of mountain bikes can be made out of steel or aluminium but it is generally made from the material aluminium. “Aluminium is widely used on mountain bikes today, such as this one, and offers a lighter, stiffer and efficient ride.” (Puliti, 2019). It is a light and strong material for a reasonable price so that’s why it is the chosen material for the majority of mountain bikes that are manufactured today. The design of the frame is diamond shaped which is important because it “links the components together in the proper geometric configuration. The frame provides strength and rigidity to the bicycle and largely determines the handling of the bicycle.” (Madehow.com, n.d.).

The typical use and work environment of a mountain bike is to go cycling off road on tough terrain, this can include dirt, mud and gravel in particular. With the tough environment, the bike needs to be strong to withstand any scratches or if someone does happen to fall off. In addition to this the bike needs to have a good suspension for there being any bumps on the journey or trail the rider is going on. The bike needs to be reliable and durable, it needs to take potential hits and still be good to use again. The bike has these requirements because it isn’t a road bike; it is for explorers and people who have a thrill of the outdoors. If the material of the bike frame happened to be easy to break or damage from being used outdoors then it would need to have the frame material changed.

The new work conditions, which is for the light endurance motorbike, means it will have to take on tougher terrain which includes sand dunes, beaches, rocks and possibly more. It is an all-terrain bike particularly used in motocross racing, so the bike needs to be able to be pushed to the limits and thrown about. An endurance bike also has the requirements of possible flexibility because of these terrains; if the frame was too rigid then the whole bike might be damaged fairly easily over time. There needs to be slight flexibility, not much but just enough so that the bike riders can do stunt jumps or go up and down over sand dunes without worry.

The design for the new frame needs to be able to hold an engine which means the frame needs to be strong but also still be fairly light in weight. The frame needs to be redesigned to then have space for the engine and other components such as fuel storage and an exhaust. With all of these factors to take in, the width of the bike will be slightly increased to be able to include all of these necessary features. When researching I thought to research an endurance bike and analyse the chassis, the motorbike I researched was the KTM 690 Enduro R 2019.

(KTM 690 Enduro R 2019, *Motocross Action Magazine*, 2019)

The endurance bike uses a “lightweight tubular trellis frame made from chrome-molybdenum steel” (KTM.com, n.d.) and that is an alloy steel which is very strong. You can have the different sizing of the tube so some areas can be thinner and some thicker which can help with managing the weight of the motorbike. This is referring to some research on the material chrome-molybdenum steel: “thin wall tubing, giving you a lightweight frame” (Detroit Bikes, 2018), and even though this is talking about a bicycles, the same thing applies for motorbikes. You can make the material to have a thin or thick wall in addition to being thicker or thinner in terms of general width of the frame billets, which will all have a factor on the weight of the light endurance motorbike.

The material chrome-molybdenum is the best choice for the frame and you can see why when you look at its properties. The way the material has been described is “A workhorse of the industry, chromoly is a light, strong steel. When it is butted and shaped to take off excess weight, it can deliver a fairly light frame that will last through years of hard use. Chromoly is responsive and offers good flex while maintaining its form.” (REI, n.d.). These properties make it the best option for an endurance motorbike since it needs to be able to withstand such extreme forces being put against it. The flexibility is an especially good and key feature for this. Aluminium and normal steel do not have properties that good which is why they are not the best options for the light endurance motorbike frame.

New part bill of materials:

Part	Quantity	Material	Manufacturing Process
Endurance motorbike frame	1	Chrome-molybdenum	1. Melting base alloys 2. Annealing 3. Cooling 4. Dip in acid to remove mill scale 5. Anneal again 6. Heat until molten 7. Pour into moulds 8. Cooling 9. Rolling 10. Cutting

A more detailed manufacturing process of new part: The new part does require a new manufacturing method which starts by melting the base alloys in a furnace and continuously annealing the outcome to remove internal stresses and toughen the material. "Annealing reduces impurities in the molten steel and improves bonding between the base elements." (Index, 2017). Eventually allow the steel to cool for hours in the air. After that you want to "dip the steel in a bath of hydrofluoric acid. The dip removes the buildup of mill scale caused by annealing. Mill scale is an iron oxide that peels from the surface of hot steel when it is air-cooled. Anneal and descale the steel one more time. Then heat the steel so it is molten again." (Index, 2017). After the steel is molten again you want to pour it into a billet mould and then allow it to cool for hours. The final two processes include rolling the billet through heated rollers to remove any surface defects and then you cut the steel to the required size it is needed for. Manufacturing process information found on sciencing.com (Index, 2017).

According to sciencing.com the newer methods for making alloy steel has been made more efficient because of the machinery is more modern, for example the use of an electric furnace over a gas furnace. (Index, 2017). Steel is 100% recyclable and that is a key factor in the process of making new steel, and that does make steel and the manufacturing process fairly sustainable. "The energy to produce a ton of steel has been reduced by 60% in the last 50 years. This is due to the following initiatives:

- A higher percentage of recycling.
- Coal producing energy is being replaced by electric power and other greener power sources.
- Implementation of management systems.
- Advancements in manufacturing techniques such as capturing carbon dioxide." (Ellefson, 2016).

This information represents how the manufacturing process of steel is continuously being improved upon to make it more sustainable and as environmentally friendly as possible. So the new part for the motorbike is recyclable and can be made with the use of recycled steel, more efficient manufacturing methods to waste energy wasted and finally, release less carbon dioxide gas that harms the environment and contributes to global warming.

The new frame material is better for the cost of making the product because of the reduction of energy that is wasted with the use of the electric furnaces. They are more expensive to run in comparison to gas furnaces and in addition to this, gas furnaces aren't as efficient due to it using fossil fuels (natural gases). The new manufacturing methods for producing steel, with the use gas furnaces, include capturing the carbon dioxide from entering the atmosphere. The way it works: "Carbon capture involves trapping the carbon dioxide at its emission source, transporting it to a storage location (usually deep underground) and isolating it. This means we could potentially grab excess CO2 right from the power plant, creating greener energy." (Ronca, n.d.). So if the electric furnaces are a bit on the expensive side to run for now they are trying to help the environment on the emissions side.

Also when they produce the alloy steel they do it in batches, like they would with anything else, so the furnaces and machinery doesn't need to be turned off and on a lot saving electricity and making the whole process more efficient. This is also because electric furnaces take time to heat up to the required temperature but it is more accurate and is able to keep the heat up with reduced energy waste. The final reason which has been already stated is the fact they don't use any fossil fuels, which is one step into the preserving the future. So electric furnaces may bit a bit more expensive but in reality they are the better option in the long run.

Bibliography

Detroit Bikes. (2018). ("thin wall tubing, giving you a lightweight frame"). *What Makes A Chromoly Bike Better?*. [online] Available at: https://detroitbikes.com/blogs/the-bike-blog/what-makes-a-chromoly-bike-better [Accessed 7 May 2019].

Ellefson, C. (2016). ("The energy to produce a ton of steel has…"). *Steel*. [online] STINNER. Available at: https://www.stinnerframeworks.com/stories-2/2016/7/20/steel [Accessed 11 May 2019].

Index, B. (2017). ("Annealing reduces impurities in the molten…"). *The Alloy Steel Manufacturing Process*. [online] Sciencing. Available at: https://sciencing.com/alloy-steel-manufacturing-process-7267414.html [Accessed 11 May 2019].

KTM. (n.d.). (“lightweight tubular trellis frame made from chrome-molybdenum steel”). *KTM 690 ENDURO R 2019*. [online] Available at: https://www.ktm.com/gb/travel/690-enduro-r/chassis [Accessed 7 May 2019].

Madehow. (n.d.). (“links the components together in the proper geometric…”). *How bicycle is made - material, manufacture, history, used, components, dimensions, machine, History*. [online] Available at: http://www.madehow.com/Volume-2/Bicycle.html [Accessed 7 May 2019].

Motocross Action Magazine. (2019). (Image). *2019 STREET LEGAL KTM 690 SMC-R & KTM 690 ENDURO R | Motocross Action Magazine*. [online] Available at: https://motocrossactionmag.com/2019-street-legal-ktm-690-smc-r-ktm-690-enduro-r/ [Accessed 7 May 2019].

Puliti, B. (2019). (“Aluminum is widely used on mountain bikes today…”). *What's the Right Mountain Bike Frame for You?*. [online] ThoughtCo. Available at: https://www.thoughtco.com/types-of-mountain-bike-frame-materials-2403708 [Accessed 5 May 2019].

REI. (n.d.). (“A workhorse of the industry, chromoly is a light, strong steel. When…”). *Understanding Bike Frame Materials*. [online] Available at: https://www.rei.com/learn/expert-advice/bike-frame-materials.html [Accessed 8 May 2019].

Ronca, D. (n.d.). (“Carbon capture involves trapping the carbon…”). *How Carbon Capture Works*. [online] HowStuffWorks. Available at: https://science.howstuffworks.com/environmental/green-science/carbon-capture.htm [Accessed 11 May 2019].