CVG 2141 - Quiz 8

1. **Describe the three types of iron components that can be used in civil engineering. Show differences and give examples of their use.**

   The three main types of iron are wrought iron, steel, and cast iron. These different types are identified by the quantity of carbon within them. Wrought iron has less than 0.1% carbon and is usually used to make pipes. The properties include it being ductile, rough, resistant to corrosion, and easily molded and welded. Moreover, the second type is steel which has 0.1 to 2% of carbon and it is typically used for building beams, columns, and trusses. Lastly, cast iron has more than 2% carbon and is used for pipes and machines. It is very strong with respect to its compressive strength, but weak in tensile strength. As well, it is very poor against cyclic loading and fire.

2. **Describe step by step the process of making steel.**
   The first step involves mixing iron ore, coal, and limestone together and melting the mixture in a blast furnace at approximately 1600°C. This produces pig iron which is a molten mixture with a reduced amount of iron content and impurities. A side by-product that is collected at the surface is slag, which is commonly used as a SCM in concrete. Next, the pig iron is refined by placing it with additional limestone and iron ore into a second furnace. If it's the first time, it will go through the basic oxygen furnace but if it's recycled scrap, then it will go to an electric arc furnace. This will help to remove any excess carbon and other impurities by oxidation and produce of liquid steel. Following this, the properties of the liquid steel are altered with the addition of alloys. The alloys will help enhance properties such as strength, durability, machinability, and resistance to corrosion. As well, this state of the steel will enable it to be casted into many different shapes. Afterwards, casting and rolling is completed in order to construct the main products in many different forms including rails, bars, plates, pipes, etc.

3. **Explain the impact of carbon content in the steel product.**

   The quantity of carbon impacts the properties of a steel product. If there is a higher carbon content, then the strength will increase while the ductility and toughness will decrease. In contrast, when carbon content decreases, the strength will decrease while the ductility and toughness will increase.

4. **What are the possible rolling types? What are the differences between them, and the products manufactured through each one?**

   Two rolling types are hot and cold rolled steel. The main difference between them is the process at which they are being made. Hot rolled steel is made under high temperatures while cold rolling is don't at around room temperature. This results in different properties being possessed by each type. Hot rolled steel can be shaped and formed easily and is

typically used to build beams, columns, and trusses. While cold rolled steel has plastic deformations resulting in higher strength and hardness but less ductility. They typically are used to produce composite slabs and roofing.

5. **Describe the 3 types of possible strengthening mechanisms for steel members.**

   The three possible strengthening mechanisms for steel members are work hardening, thermal treatments, and adding additional alloys. Work hardening is when hardening occurs after cold treatment (rolling milling). This is since the cold treatment leads to plastic deformations. The second mechanism is thermal treatments which describes when the heating or cooling is controlled. This impacts the hardness, strength, and ductility of the steel. Specifically, when looking at the cooling rate of the steel, if there is a slow cooling rate there will be coarser grains and in turn a higher ductility. While if there is fast cooling, there will be finer grains and a higher strength. There are three types of thermal treatments including annealing, hardening, and tempering. The annealing technique involves preheating the steel and slowly cooling it down by controlling the temperature. The goal of annealing is to refine the grains, soften the steel, remove internal stresses and increase ductility and toughness. The hardening treatment consists of preheating the steel and then quickly cooling it by soaking it into water. This helps to increase hardness, stiffness, and strength. Typically following hardening, a tempering treatment takes place. It involves heating the steel and then cooling it by air. This will improve the ductility and toughness of the steel. Additional alloys are used since they can enhance some of the properties of steel. For instance, it can improve the hardness, machinability, ductility, toughness, strength, and resistance to corrosion.

6. **Show the parameters necessary for the development of steel corrosion. Indicate the different forms of corrosion and strategies to control it.**

   The different parameters required for corrosion is the presence of an anode, cathode, electrical connection (conductor), and electrolyte. Moreover, steel corrosion can occur in 3 different forms: general corrosion, localized corrosion, and galvanic corrosion. General corrosion looks very uniform and occurs due to the external environment or atmosphere. Localized corrosion is very punctual as it removes complete sections of material. Thus, it is more aggressive than the general corrosion. Lastly, there is galvanic corrosion which takes place when a more and less noble metal are in contact resulting in the lesser noble metal to corrode. Strategies for controlling corrosion include the usage of protective barriers (isolating steel from moisture), sacrificial protective barriers (sacrifice surface metal over steel) cathodic protection (using a current from an external source), or corrosion resistance steels.