

Materials Exam

Question 1.

a) Resistance welding includes spot, seam & projection welding. Spot welding is where two pieces of materials pass between 2 electrodes, one positive and the other negative. The two electrodes spot weld the workpiece and release. The spot weld can be weak if the current isn't strong enough, hot enough or if the materials aren't held together with enough force. Warping can occur around the point where the spot weld is.

Seam welding is where two electrode wheels, with sliding contactors connected to an AC current supply roll metal sheets which are then welded at the seam. The benefits of seam welding is that it is continuous through the whole length of the sheet.

Projection welding is where projections are put under welding pressure from two water cooled copper alloy electrodes. The benefit of this method is that it holds the materials tighter together but it isn't the best weld.

Overall spot welding is good but a drawback is that the electrode can sometimes weld to the material. Seam welding is very similar to spot welding but it is continuous. Also, the copper can weld to itself.

Q1

b) Metal arc is when a filler rod is heated by a tungsten electrode which creates a weld pool, which in turn creates a weld.

Dip transfer tends to create a turbulent weld which is where there is an unsteady or unstable movement of air in the form of arifice gas or shielding gas. Dip transfer is less than 200 amps. The arc produces a weld pool, the electrode then touches the weld pool which increases the power due to a short circuit. This will melt the electrode tip before the arc is re-established.

Spray transfer is more than 200 amps because the current is increased to stop dip welding. This method is slightly better but material is lost through this process. The arc produces a weld pool, the electrode tip becomes molten and the forces pull the droplet to the weld pool. This forces the droplet to be released and then the cycle starts again.

Pulse transfer is where background current is present with peaks of higher current. This low current keeps the weld pool molten but when the increase current occurs the tip melts which forces the droplet to weld pool and this is then released. The cycle then restarts.

In dip transfer the tip sticks to the weld and wire can also burn back into the gun.

Question 2

a) The key factors in thermal spraying are the heat source to ensure it is enough to melt the wire or powder or the particle speed. The heat can be lower if the particle speed is fast enough.

There are 5 types of thermal spray which are:

- * Combustion and air
- * HVOF Spraying
- * Detonation gun spraying
- * Arc/Wire spraying
- * Plasma spraying

Combustion and air spraying has good adhesion with w. few holes in the surface.

HVOF spraying has the best adhesion with very few holes but also far less oxide.

Detonation spraying is currently experimental but this method would ideally be hand held which would be the most ideal sprayer.

Arc or Wire spraying is cheap and simplistic but it has a much thicker coating. This method has lower speeds than HVOF but better than combustion.

Finally, Plasma spraying gives a hard coating but this method is very costly.

Q2.

- a) The health and safety concerns with these methods are the sound and the dust or particles they create. It is vital that hearing protection and dust mask are worn.

Q2

b) The three stages of creep are Primary, Secondary and Tertiary. The primary stage is where the grains of the structure begin to twist. The secondary stage is generally where we can predict the linear failure. This is where dislocations occur and move toward the grain triple points. This is where holes gather to create dislocation & move to the grain boundary which is the weakest point. At the tertiary stage the holes gather to create cavities which ultimately leads to failure.

One way to minimize the risk of creep is to reduce the grain size of the material to prevent dislocations

Second is a single grain structure which is optimal when looking at creep. These materials are very expensive and difficult to acquire.

Thirdly, ~~staying~~ a material with large grains can reduce creep because less grain boundary sliding occurs.

Finally, alloy materials can help avoid creep by eliminating microstructural vacancies in material.

Q3

a)

Electric arc furnaces run at 100 MW. which is a massive cost compared to blast furnaces. Electric arc furnaces only ^{use} recycled steels which have much higher impurity levels than iron ore like sulphur which comes from rubber and also phosphorus which is from dirt and organic materials. These ~~modern~~ impurities cause inclusions in the steel. Copper, tin and zinc segregate at the grain boundaries of steel which affects its mechanical properties. Products like chromium are common for alloying steel so these materials aren't a problem at low levels.

b) Stainless steel is made up of steel, chromium and nickel. Chromium in the stainless is what stops it from rusting. The chromium gives an oxide layer which protects the material but if the chromium content is below 12% it won't be enough and it will corrode. Nickel is added to increase the malleability of the material. An area where stainless is very poor is under water. Due to no oxygen the chromium can't provide an oxide protection layer so the material corrodes.

Q4

- a) The bike frame should have a certain
b) strength to stop the frame from breaking, the
density should remain low. While being strong
the material should remain stiff to prevent the
bike from moving while riding or going over jumps.
The fatigue levels of the material should remain
high at all times. The weight of the bike is
important to make it easier for the rider.

c) The materials to investigate would be:

- * ~~Treated bamboo~~ Bamboo ||
- * Ash ||
- * Oak ||
- * ~~Maple~~ Maple ||

d) The materials I would reject would be.

- * ~~Human skin~~ Human skin due to flexibility and elasticity
- * Tomato as it is too soft and would damage if
bumped.
- * Artery would have too much elasticity
- * Ligament as it again has too much elasticity to
support a bike.

e) The density is too ^{high} as all of these materials
and the strength is low at these materials. I
believe some do have the capabilities to resist
fatigue. The overall tensile strength is too low

f) The hardness of the material would be important
as if it is too high the material could chip
or shatter. Also, the melting point would be
important on a warm summer day as the
material could become more elastic or
melt.