UNIVERSITI TEKNOLOGI MARA

THE EFFECTS OF STRAIN AND HEAT ON SMART MATERIAL SHAPE MEMORY ALLOY

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ABSTRACT

The presence of Shape Memory Alloy (SMA) in civil engineering fields was an eye-opener for researchers to develop better technology which can aid in various related aspects. The superiority of SMA over other materials is that it has a special capability where it can remember the previous shape and able to return back to its original shape after applied a certain heat directly to it. The usage of SMA is tremendous in other applications such as in medical and dentistry also in automotive and robotic. However, SMA in structural applications is still considered as new and still in the research area. To install this material in the structures, the material itself must be thoroughly examined. This study was focused on the effects of strain and heat towards SMA. It is essential to conduct ageing studies on SMA, where ageing mechanism can provide a better control and development of SMA for engineering application and also by understanding of strain rate will ensure it meets the performance specification required in the end use for application. The influence of pre-strain and heat on the mechanical behaviour of Ni-Ti shape memory alloy bars were examined in room temperature with concerns of different strain rates, which are lxlO"^{3} s"^{1}, 5.5xl0"^{4} s"^{1} and lxlO"^{4} s"^{1}. Each of the test pieces was pre-strained at level 5£$_{y}$, 10£$_{y}$ and 15£$_{y}$. The pre-strained specimen, then heat treated at 300°C and 500°C. A quasi static tensile test was carried out on heat treated Ni-Ti by using a Universal Testing Machine to observe the Ni-Ti stress-strain responses. The results show that different strain rates do give effect to the Ni-Ti performances. For Ni-Ti heat at 500°C, the yield strength of Ni-Ti bars increases when the strain rate is decreasing. It is typical for super-alloys to exhibit such sequence due to their use in applications requiring high strength at high temperature. But for Ni-Ti heat at 300°C the results for yield strength were varied where it does not follow the sequence. For level of pre-strain, strength of Ni-Ti were increased above control specimen after applying pre-strain (5£$_{y}$, 10£$_{y}$ and 15£$_{y}$) and heat at 500°C at each strain rate (lxlO^{3} s"^{1}, 5.5XKT^{4} s"^{1} and lxlO"^{4} s^{-1}). For Ni-Ti heat at 300°C, the strength of Ni-Ti for each pre-strain only increase above the control specimen at a strain rate lxlO"^{4} s"^{1}. It shows heat treatment at 300°C is not sufficient for higher strain rate. Furthermore, it was found that both heat treatment at 300°C and 500°C shows when the strain rate getting slower, tensile strength of Ni-Ti are decreased at the level of 10£$_{y}$ -15£$_{y}$. So, it indicates that strain ageing of Ni-Ti bars at a large strain becomes practically irrelevant, even though Ni-Ti is a super-alloys. However, it is proved in this study that heat treatment at 500°C is sufficient for Ni-Ti rather than heat treatment at 300°C

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