Calculation of T5 and T6 Peak Strengths

As part of the development of a mechanical properties capability for JMatPro, a methodology has been developed that will allow the peak strengths in the T5 and T6 temper conditions to be calculated. It relies on knowledge of the type and amount of metastable phases that govern strength in these temper conditions, which can be calculated using existing capability in JMatPro.

The cornerstone of the strategy lies in the reverse analysis of known strengths of Al-alloys tempered primarily in the T6 condition. The key then lies in using well established strength models and back calculating precipitate densities that would provide the mechanical properties achieved in practice. This reverse analysis shows that experimentally observed strengths are associated with characteristic precipitate densities, N_v^{crit}, that lie in a narrow band and which are rather constant.

Using the back calculated N_v^{crit} and the calculated volume fraction of hardening precipitate then allows the prediction of strength for alloys of the 2xxx, 6xxx and 7xxx classes. As the tempering treatment for the T6 condition is usually optimised to produce the maximum strength for that alloy, the current approach is taken to calculate the peak strength. Figure 1 shows the comparison between calculated and observed T6 strengths for a wide range of Al-alloys, including both wrought and cast alloys. For the case of wrought alloys, experimental strengths were mainly taken from the ASM handbook, with additional references from Al producers' datasheets, while strengths of cast alloys were predominantly taken from T6 tempered die-cast alloys reported by CSIRO, Australia in various publications.

A significant advantage of the approach is that it provides the radius of the precipitate, which can then be used in standard JMatPro coarsening equations to allow the degradation of strength as a function of time at high temperature to be calculated, leading the way to the calculation of strength of Al-alloys as a function both of the temperature of measurement and which also takes into account their previous time-temperature history.

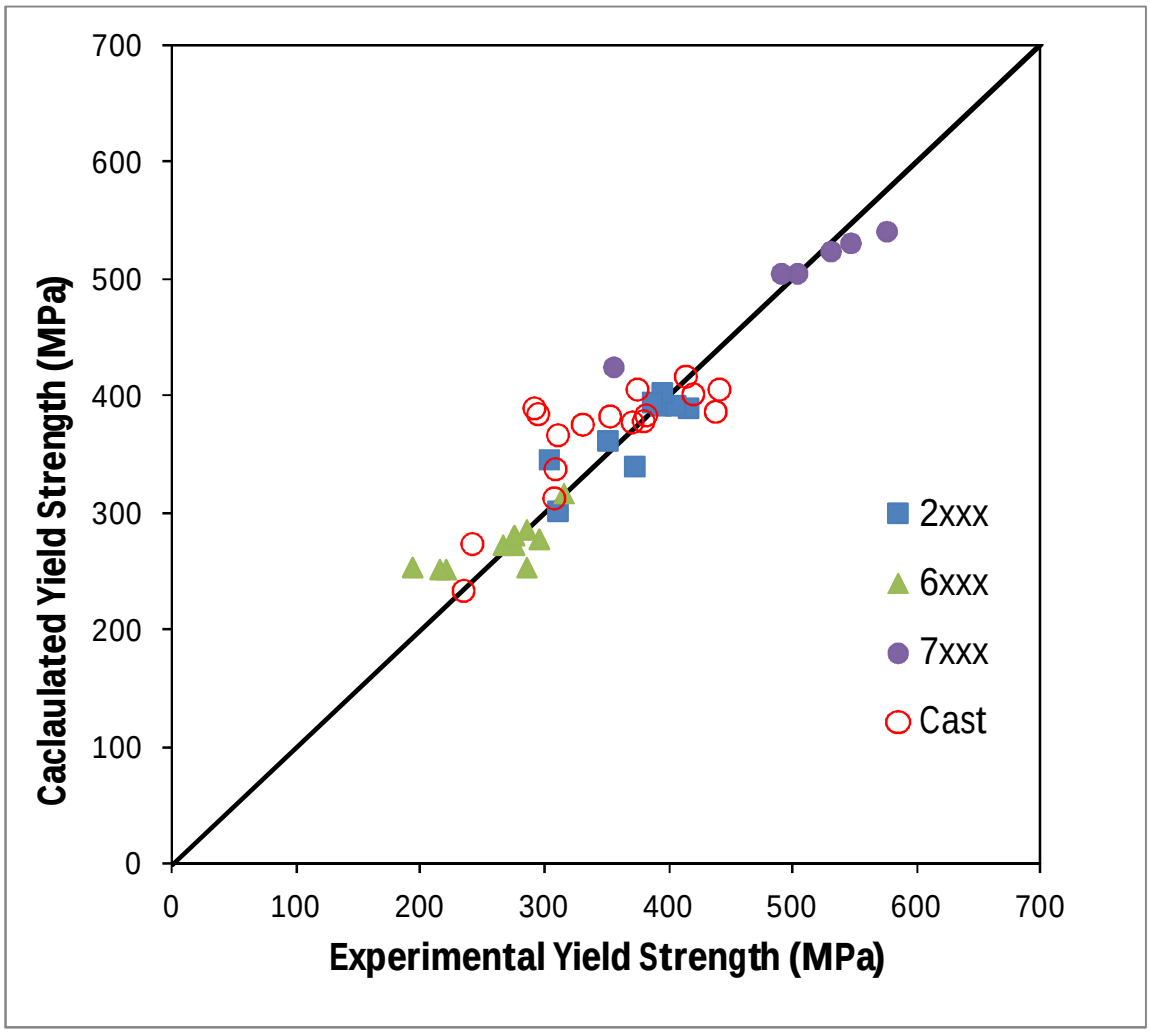

Figure 1. Comparison between calculated and experimentally observed T6 strengths for various Al-alloys