Development of methodology for determination of fracture property at high strain rate loading using SHPB facility

SHPB test facility was modified to accommodate Single Edge notched Bend (SE(B)) specimen. For this a new incident bar was developed with wedge end to load the specimen and a fixture (anvil) is introduced to support the specimen at two points, the anvil itself was supported by transmission bar as shown in figure 1 below.

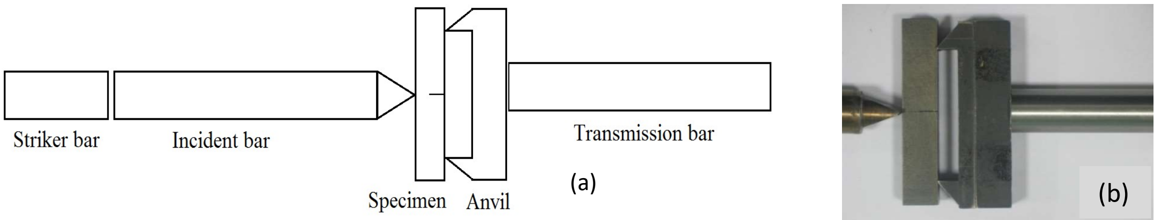

Figure 1. (a) Schematic of modified SHPB arrangement, (b) Specimen loaded in SHPB

As the ferritic grade steel is widely used in nuclear industry for fabrication of casks, vessels and piping etc. To ensure structural integrity under worst case scenario, postulated accident conditions such as seismic loading on piping and structures, impact of transportation cask on a rigid surface etc. are considered for design and safety analysis of these structures. Under such postulated accident scenario, the loading rate on structures are high and temperatures can also be a variable. Thus, for design and safety analysis of these structures, material properties under high strain rate loading at wide temperature range and constitutive model to predict such behaviour are necessary. Considering this, a methodology to determine fracture properties under high strain rate loading is developed using the modified SHPB and fracture studies of SA516Gr.70 steel is carried out in a wide range of strain rates (1e-3 to 1e+3/s) in DBTT regime (RT to -125 ^{0}C). High strain rate tests were carried out using Split Hopkinson Pressure bar (SHPB). The results of fracture tests at different loading rates are shown in the form of master curve in Fig.2. It is apparent from the test results that the fracture toughness and scatter in fracture data decreases with increase in loading rate. It can be observed that the Reference temperature T_0 has a large positive shift with increasing loading rate. Thus, probability of fracture increases at high loading rates and hence fracture toughness decreases.

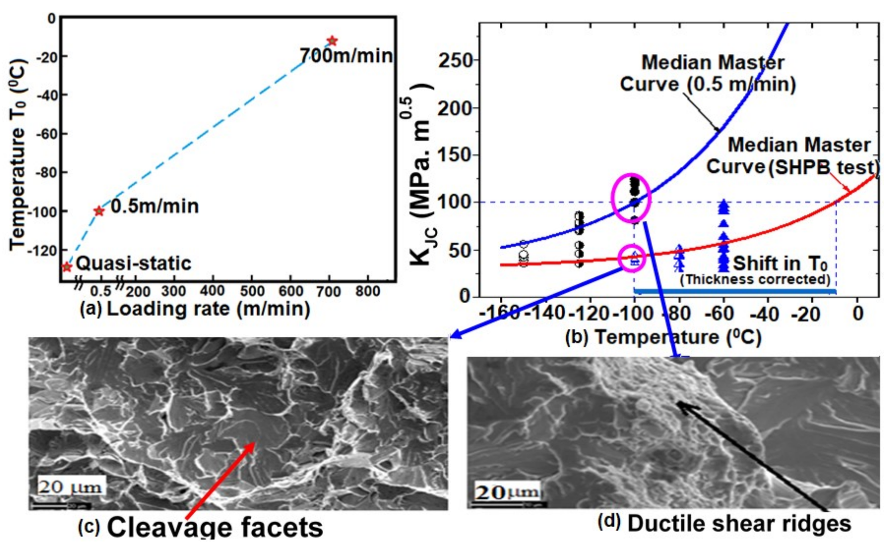

Figure 2. (a) Variation of reference temperature T_0 with loading rate, (b) comparison of master curve at 0.5m/min and 700m/min and shift in T_0 (c) Cleavage fracture at -100 ^{0}C at 700m/min and (d) ductile ridges at 0.5m/min at -100 ^{0}C