This thesis in focused on revealing deformation mechanisms resulting in high-strength and moderate elongation of the $Mg_{97.94}Zn_{0.56}Y_{1.5}$ (at. %) alloys prepared by rapidly solidified ribbon consolidation technique. The processing method alongside with low alloying content results a fine-grained microstructure with Zn- and Y-rich stacking faults formed in the basal planes. In addition, the extruded from cast ingot alloys of the same composition, characterized by homogeneous microstructure with large gains and presence of long-period stacking order (LPSO) phase have been used as a reference material. The latter alloys are showing better ductility but lower strength compared to the rapidly solidified ribbon consolidated alloys. Besides, the effect of extrusion ram speed on microstructure and resulting mechanical properties is addressed. Microstructure observations has been performed using light and scanning electron microscopy. Lower values of yield strength in tension compared to that in compression motivated further detailed investigation using advanced technique. Thus, *in-situ* synchrotron X-ray diffraction method has been employed for analysis of the deformation mechanisms, indicating the activation of non-basal slip systems alongside the primary basal slip system, with negligible twinning. Moreover, particular attention has been paid to revealing background mechanisms leading to yield point phenomenon.