Cryogenically flexible polyurethane (PU) foam particles at various concentrations were introduced as a new filler into the natural rubber compounds and the rheological properties were studied using a Davenport Capillary Rheometer. The effect of mastication time and die temperature on rheological properties and extrudate swell behaviour of the rubber compounds was also investigated. It was found that rheological properties and extrudate swell ratio changed considerably with addition of PU filler, mastication time and die temperature. With respect to rheological behaviour, it is recommended that 20–30 pph PU filler is the optimum concentration to be introduced into natural rubber Compounds under the mastication time of 15 minutes for a given die temperature.