Grouted joints for offshore wind turbines forming the connection between the transition piece to the monopile and tower are one of the weakest links of the support structure. The grout being a reinforced concrete material is susceptible to cyclic loading comprising of tensile and compressive components. As offshore wind turbines reach 10 MW capacities, it is extremely important to determine the reliability of grouted joints and their design configurations so as to ensure integrity of the 10 MW support structure. This report investigates two types of grouted joint connections, the conventional cylindrical joint with shear keys and a conical joint without shear keys. In both cases, fully coupled load simulations are made to determine the fatigue resistance and ultimate load resistance of the joint. Key recommendations are made for the reliable design of grouted joints for 10 MW wind turbines on monopile substructures.