In engineering applications, one of the major challenges today is to develop reliable and robust control algorithms for complex networked systems. Controllability and observability of such systems play a crucial role in the design process. The underlying network structure may contain symmetries – caused, for example, by the coupling of identical building blocks – and these symmetries lead to repeated eigenvalues in a generic way. This complicates the design of controllers since repeated eigenvalues decrease the controllability of the system. In this paper, we will analyze the relationship between the controllability and observability of complex networked systems and symmetries using results from group representation theory. Furthermore, we will propose an algorithm to compute sparse input and output matrices based on projections onto corresponding isotypic components. We will illustrate our results with the aid of two guiding examples, a network with D4 symmetry and the Petersen graph.