This thesis focuses on polymer-matrix composites, such as carbon fibre/epoxy or glass fibre/polyester composites, which are used in many light-weight structures including aerospace structures, ships, aircraft and wind turbine blades. Usually, polymer-matrix composites are used in the form of multi-directional laminates that are bonded together by adhesive joints, since thermosetting polymers, unlike metals, cannot be welded together. The structure can therefore fail by: - delamination (cracking along interfaces between layers inside the laminates) - adhesive joint failure (cracking along the laminate/adhesive interfaces) Such failures often involve crack bridging by intact fibres behind the damage front. The length of the fracture process zone can be of the order of several centimetres. The present study is motivated by a desire to be able to determine cohesive laws for such large-scale fracture processes, allowing delamination and adhesive joint failure to be accurately characterised in terms of a material model, the cohesive law, which is then the source for accurate prediction of the load-carrying capability of structures through cohesive zone models that accounts for the large-scale fracture process zone.