A novel double cantilever beam test method for interface fracture toughness characterization of debonded sandwich composites is introduced. The method is called DCB-UBM (Double Cantilever Beam loaded with Uneven Bending Moments), where pure moments are applied to the beams at the crack end using torsional actuators, to generate crack propagation along the face sheet/core interface. A data reduction method is proposed to determine the fracture toughness. Fracture testing is performed on a typical marine grade sandwich configuration consisting of PVC H45 foam core and glass fiber face sheets to demonstrate the applicability of the test method. The obtained fracture toughness agrees with interface toughness values in the literature measured using other test methods with the same material system. The effective kinematics of the test rig is measured using Digital Image Correlation (DIC) by studying the rotations and moments of a specially designed calibration specimen and comparing the results against finite element results. The DCB-UBM specimen and test method is a promising candidate for obtaining face sheet/core interface fracture toughnesses in sandwich composites.