Repair and rehabilitation of structures

Homework no.5

A simply-supported singly-reinforced concrete beam must be able to carry a uniformly distributed factored load (including self-weight) of 1.75 k/ft (25.5 kN/m). If the beam has a span of 13.2 ft (4.0 m) and has the dimensions and reinforcement details shown in the accompanying figure, determine if strengthening the beam in flexure with layers of carbon FRP sheets is sufficient to obtain the required flexural capacity. The beam strengthened with carbon FRP on its soffit. Beam dimensions and reinforcement details are shown in the figure below. The material properties are as follow:

- Concrete strength, $f_c' = 5800$ psi (40 MPa)
- steel reinforcement: 4 #3 bars
- Steel yield strength, $f_y = 58$ ksi (400 MPa)
- Steel elastic modulus, $E_s = 29000$ ksi (200 GPa)
- Carbon FRP thickness, $t_{frp} = 0.035"$ (0.89 mm)
- CFRP failure strain, $(\epsilon_u)_{frp} = 1.26$ %
- CFRP elastic modulus, $E_{frp} = 11150$ ksi (76.9 GPa)
- FRP material resistance factor, $C_E = 0.75$