3) Steel Reinforcement

a) Near midspan AB

Assuming diameter of main steel $\phi = 12$ mm, diameter of links $\phi' = 8$ mm and nominal cover $c = 30$ mm hence effective depth, $d = D - c - \phi' - \phi/2 = 500 - 30 - 8 - 12/2$

$= 456$ mm

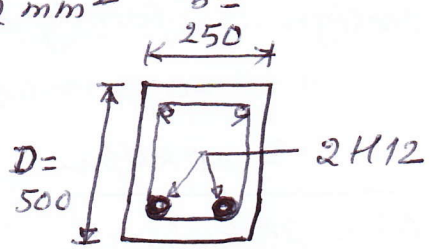
$$K = \frac{M}{f_{cu} b d^2} = \frac{32 \times 10^6}{30 \times 250 \times 456^2} = 0.0205$$

$$z = d\left[0.5 + \sqrt{0.25 - K/0.9}\right] = 456\left[0.5 + \sqrt{0.25 - 0.0205/0.9}\right] = 445 \text{ mm}$$

but, $z \leq 0.95d \leq 0.95 * 456 \leq 433$ mm

∴ Area of steel reinforcement,

$$A_s = \frac{M}{0.87 f_y z} = \frac{32 \times 10^6}{0.87 * 400 * 433} = 212 \text{ mm}^2$$



Provide 2H12 ($A_s = 226$ mm^2)

b) mid span BC

$$K = \frac{M}{f_{cu} b d^2} = \frac{20 \times 10^6}{30 * 250 \times 456^2} = 0.013$$

$$z = 456\left[0.5 + \sqrt{0.25 - 0.013/0.9}\right] = 449 \text{ mm}$$

but $z \leq 0.95d \leq 433$ mm

∴ Area of steel reinforcement, $A_s = \frac{20 \times 10^6}{0.87 \times 400 \times 433} = 132.73 \text{ mm}^2$

Provide 2H10 ($A_s = 157$ mm^2)

c) mid span CD

$$K = \frac{M}{f_{cu} b d^2} = \frac{4.1 \times 10^6}{30 \times 250 \times 456^2} = 0.0026$$

∴ Area of steel reinforcement,

$$A_s = \frac{4.1 \times 10^6}{0.87 * 400 * 433} = 27.21 \text{ mm}^2$$

$$z = 456\left[0.5 + \sqrt{0.25 - 0.0026/0.9}\right]$$

$= 454$ mm, but

$z \leq 0.95d \leq 433$ mm

Provide 1H10 ($A_s = 78$ mm^2)