ASSIGNMENT 5

Q1

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# Program to calculate ultimate moment carrying capacity of singly reinforced beam
fck = float(input("Enter characteristic compressive strength (fck in MPa): "))
fy = float(input("Enter grade of steel (fy in MPa): "))
Es = float(input("Enter Modulus of Elasticity of steel (Es in MPa): "))
b = float(input("Enter width of beam section (b in mm): "))
d = float(input("Enter effective depth (d in mm): "))
d1 = float(input("Enter diameter of first bar (mm): "))
d2 = float(input("Enter diameter of second bar (mm): "))
n = int(input("Enter number of bars for each type: "))
Ast1 = n * 0.7854 * d1 * d1
Ast2 = n * 0.7854 * d2 * d2
Ast = Ast1 + Ast2
print("Area of steel (Ast1):", Ast1)
print("Area of steel (Ast2):", Ast2)
print("Total area of steel (Ast):", Ast)
# Neutral axis factor
ku = 0.0035 / (0.0055 + (fy / (1.15 * Es)))
print("Neutral axis factor (ku):", ku)
# Moment of resistance factor
Ru = 0.36 * fck * ku * (1 - (0.42 * ku))
print("Moment of resistance factor (Ru):", Ru)
# Maximum neutral axis depth
xumax = ku * d
print("Maximum neutral axis depth (xumax):", xumax)
# Actual neutral axis depth
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xu = (0.87 * fy * Ast) / (0.36 * fck * b)
print("Actual neutral axis depth (xu):", xu)
# Check reinforcement type
if xumax > xu:
   print("Under Reinforced")
else:
   print("Over Reinforced")
# Enter neutral axis depth for moment calculation
x = float(input("Enter neutral axis depth (x in mm): "))
Mu = 0.36 * fck * x * b * (d - 0.42 * x) * 1e-6
print("Ultimate Moment of Resistance (Mu):", Mu, "kNm")
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OUTPUT-

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Enter characteristic compressive strength (fck in MPa): 20
Enter grade of steel (fy in MPa): 415
Enter Modulus of Elasticity of steel (Es in MPa): 200000
Enter width of beam section (b in mm): 230
Enter effective depth (d in mm): 400
Enter diameter of first bar (mm): 20
Enter diameter of second bar (mm): 16
Enter number of bars for each type: 2
Area of steel (Ast1): 628.32
Area of steel (Ast2): 402.1248
Total area of steel (Ast): 1030.4448
Neutral axis factor (ku): 0.4791666666666667
Moment of resistance factor (Ru): 2.7556874999999996
Maximum neutral axis depth (xumax): 191.66666666666669
Actual neutral axis depth (xu): 224.66310086956523
Over Reinforced
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Enter neutral axis depth (x in mm): 191.666667

Ultimate Moment of Resistance (Mu): 101.40930013192798 kNm

Q2

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#Design of Slab
# Given Data
# Effective span is already given in question
span = float(input("Enter the value of effective span in meters: "))
b = float(input("Enter the value of width of slab in mm: "))
bs = float(input("Enter the value of Support Width in meters: "))
fck = float(input("Enter the value of Characteristics Compressive Strength: "))
fy = float(input("Enter the value of grade of steel: "))
Es = float(input("Enter the value of Modulus of Elasticity: "))
LL = float(input("Enter the value of Live Load: "))
FF = float(input("Enter the value of Floor Finish: "))
Density = float(input("Enter the value of Density of RCC: "))
# Design Constants
# Neutral Axis Factor
ku = 0.0035 / (0.0055 + (fy / (1.15 * Es)))
print("The value of Neutral Axis Factor (ku) is:", ku)
# Moment of Resistance Factor
Ru = 0.36 * fck * ku * (1 - (0.42 * ku))
print("The value of Moment Resistance factor (Ru) is:", Ru)
# Assuming pt = 0.5 from Fig.4 from IS 456:2007 page no.38
fs = float(input("Enter the value of Steel Stress of Service: "))
# From Graph find out the Modification Factor
MF = float(input("Enter the value of Modification Factor: "))
# From Clause 23.2.1 Select span/d Ratio
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S = float(input("Enter the value of span/d ratio: "))
# Correction Factors
k1 = float(input("Enter the value of Correction factor if span > 10m (k1): "))
k2 = float(input("Enter the value of Tension r/f correction factor (k2): "))
k3 = float(input("Enter the value of Compression r/f correction factor (k3): "))
k4 = float(input("Enter the value of correction factor in case of flanged section (k4): "))
# Effective depth
d1 = (span * 1000) / (S * MF * k1 * k2 * k3 * k4)
print("The value of effective depth as per deflection criteria is:", d1)
# Define Effective depth and overall depth
d = float(input("Enter the value of Effective depth in mm (d): "))
D = float(input("Enter the value of Overall depth in mm (D): "))
# Load Calculations
# Self Weight of slab
DL = D * Density / 1000
print("The Dead load is:", DL)
# Total Load
Factor = float(input("Enter the value of Partial Safety Factor: "))
TL = DL + LL + FF
print("The value of total load is:", TL)
Wu = Factor * TL
print("Wu =", Wu)
# Bending Moment Calculations
Mu = Wu * span * span / 8
print("The value of Bending Moment (Mu) is:", Mu)
# Check for effective depth
d2 = (Mu * 1000000 / (Ru * b)) ** 0.5
print("The value of Effective depth as per Moment criteria:", d2)
if d2 > d:
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    print("Revise the Depth:")
else:
    print("SAFE")
d = float(input("Enter the value of Effective depth in mm (d): "))
# Minimum Steel Calculations
Astmin = 0.12 * b * D / 100
print("The value of Minimum steel is:", Astmin)

# Main Steel Calculations
Ast = (0.5 * fck * b * d / fy) * (1 - ((1 - ((4.6 * Mu * 1000000) / (fck * b * d * d))) ** 0.5))
print("Ast:", Ast)
# Check for Ast
if Ast < Astmin:
    print("Take Ast = Astmin")
else:
    print("Ast > Astmin, Hence SAFE")
# Bar diameters
dia1 = float(input("Enter the value of bar diameter for main steel: "))
dia2 = float(input("Enter the value of bar diameter for Distribution steel: "))
# Area of bars
ao1 = 0.7854 * dia1 * dia1
print("The Value of Area of main steel bar (ao1):", ao1)
ao2 = 0.7854 * dia2 * dia2
print("The Value of Area of distribution steel bar (ao2):", ao2)
# Spacing Calculations
Spacing1 = ao1 * b / Ast
print("The spacing for main steel bars is:", Spacing1)
Spacing2 = ao2 * b / Astmin
print("The spacing for distribution steel bars is:", Spacing2)
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# Checks for main steel
print("Check 1 for main steel")
if Spacing1 > 300:
    print("UNSAFE")
else:
    print("SAFE")
print("Check 2 for main steel")
if Spacing1 > 3 * d:
    print("UNSAFE")
else:
    print("SAFE")
# Checks for distribution steel
print("Check 1 for Distribution steel")
if Spacing2 > 300:
    print("UNSAFE")
else:
    print("SAFE")
print("Check 2 for Distribution steel")
if Spacing2 > 5 * d:
    print("UNSAFE")
else:
    print("SAFE")
# Approximated values of Spacing
S1 = float(input("Enter the value of spacing of main bars: "))
S2 = float(input("Enter the value of spacing of distribution bars: "))
Astprovided = ao1 * b / S1
print("The provided steel area for main bars at section in mm^2 is:", Astprovided)
Astprodist = ao2 * b / S2
print("The provided steel area for distribution bars at section in mm^2 is:", Astprodist)
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```
# Check for Shear
Vu = (Wu * span / 2) - (Wu * ((bs / 2) - (d / 1000)))
print("The value of SF at a Section is:", Vu)
SStress = (Vu * 1000) / (b * d)
print("The value of shear stress is:", SStress)
# From table 20 IS 456:2007 page 73
SStressmax = float(input("Enter the value of maximum Shear stress: "))
if SStress > SStressmax:
    print("Crushing will happen")
else:
    print("SAFE")
# Percentage Steel
pt = (100 * Ast) / (b * d)
print("The value of percentage steel is:", pt)
# From table 19 IS 456:2007 page 73
SS = float(input("Enter the value of Shear Stress: "))
k = float(input("Enter the value of depth factor: "))
Shear = k * SS
print("The value of shear at section is:", Shear)
if SStress > Shear:
    print("Shear Reinforcement Required")
else:
    print("Shear Reinforcement not Required, SAFE")
# Check for Deflection
ActDEF = span * 1000 / d
print("The value of span/d is:", ActDEF)
MaxDEF = S * MF * k1 * k2 * k3 * k4
print("The permissible deflection is:", MaxDEF)
if MaxDEF > (span / d):
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    print("SAFE")
else:
    print("UNSAFE")
# Check for Anchorage Length
M1 = 0.87 * fy * Ast * (d - (fy * Ast) / (fck * b))
print("The value of Moment (M1) is:", M1)
lo = 8 * dia1
La = 1.3 * (M1 / Vu) + 10
print("The value of Anchorage length is:", La)
# Development Length
bondS = float(input("Enter the value of Bond Stress: "))
Ld = (0.87 * fy * dia1) / (4 * bondS * 1.6)
print("The value of Development length is:", Ld)
if La > Ld:
    print("SAFE")
else:
    print("Increase anchorage")
```

OUTPUT-

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Enter the value of effective span in meters: 3
Enter the value of width of slab in mm: 1000
Enter the value of Support Width in meters: 0.23
Enter the value of Characteristics Compressive Strength: 20
Enter the value of grade of steel: 415
Enter the value of Modulus of Elasticity: 200000
Enter the value of Live Load: 4
Enter the value of Floor Finish: 1.8
Enter the value of Density of RCC: 25
The value of Neutral Axis Factor (ku) is: 0.4791666666666667
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The value of Moment Resistance factor (Ru) is: 2.7556874999999996

Enter the value of Steel Stress of Service: 240

Enter the value of Modification Factor: 1.2

Enter the value of span/d ratio: 20

Enter the value of Correction factor if span > 10m (k1): 1

Enter the value of Tension r/f correction factor (k2): 1

Enter the value of Compression r/f correction factor (k3): 1

Enter the value of correction factor in case of flanged section (k4): 1

The value of effective depth as per deflection criteria is: 125.0

Enter the value of Effective depth in mm (d): 130

Enter the value of Overall depth in mm (D): 150

The Dead load is: 3.75

Enter the value of Partial Safety Factor: 1.5

The value of total load is: 9.55

Wu = 14.325000000000001

The value of Bending Moment (Mu) is: 16.115625

The value of Effective depth as per Moment criteria: 76.473082008588

SAFE

Enter the value of Effective depth in mm (d): 130

The value of Minimum steel is: 180.0

Ast: 364.7577413804497

Ast > Astmin, Hence SAFE

Enter the value of bar diameter for main steel: 10

Enter the value of bar diameter for Distribution steel: 8

The Value of Area of main steel bar (ao1): 78.54

The Value of Area of distribution steel bar (ao2): 50.2656

The spacing for main steel bars is: 215.32099552640113

The spacing for distribution steel bars is: 279.25333333333333

Check 1 for main steel

SAFE

Check 2 for main steel

SAFE

Check 1 for Distribution steel

SAFE

Check 2 for Distribution steel

SAFE

Enter the value of spacing of main bars: 210

Enter the value of spacing of distribution bars: 270

The provided steel area for main bars at section in mm^2 is: 374.0

The provided steel area for distribution bars at section in mm^2 is: 186.1688888888889

The value of SF at a Section is: 21.702375

The value of shear stress is: 0.16694134615384615

Enter the value of maximum Shear stress: 2.8

SAFE

The value of percentage steel is: 0.28058287798496134

Enter the value of Shear Stress: 0.378

Enter the value of depth factor: 1.3

The value of shear at section is: 0.4914

Shear Reinforcement not Required, SAFE

The value of span/d is: 23.076923076923077

The permissible deflection is: 24.0

SAFE

The value of Moment (M1) is: 16123682.812500006

The value of Anchorage length is: 965839.2079207924

Enter the value of Bond Stress: 1.2

The value of Development length is: 470.1171875

SAFE