Simply supported and cantilever beams beam construction essay

Design

A beam is a structural member which safely carries tonss i. e. without neglecting due to the applied tonss. We will be restricted to beams of unvarying cross-sectional country.

Simply Supported Beam

A beam that rests on two supports merely along the length of the beam and is allowed to debar freely when tonss are applied. Note – see subdivision A of unit.

RoentgenRoentgenForce (Load)Force (Load)Force (Load)Beam Cross Section

Cantilever Beam

A beam that is supported at one terminal merely. The terminal could be built into a wall, bolted or welded to another construction for agencies of support. Rw – reaction at wallForce (Load)Beam Cross Section

Point or Concentrated Load

A burden which acts at a peculiar point along the length of the beam. This burden is normally called a force (F) and is stated in Newtons (N) . A mass may be converted into a force by multiplying by gravitation whose value is changeless at 9.

81 m/s2. BacillusAFRubidiumRAF = m x g (N)

Uniformly Distributed Load (UDL)

A burden which is dispersed equally over a given length of the beam. This may be the weight of the beam itself. The UDL is quoted as Newtons per meter (N/m) . UDL (N/m)BacillusARARubidium

Beam Failure

If inordinate tonss are used and the beam does non hold the necessary stuff belongingss of strength so failure will happen. Failure may happen in two ways: -By shearing across the cross sectional country of the beam due to inordinate shear force. RoentgenExcessiveShear Force

Shear Failure

RoentgenExcessiveShear ForceBy flexing of the beam due to inordinate tensile and/or compressive emphasiss set up by flexing minutes.

Top of beam in compaction

Bending Failure

Bottom of beam in tensenessRoentgenRoentgen

Simply Supported Beam with Point Load

6 mFTocopherolCalciferolCARARoentgeniumF = 12 kNWe must foremost cipher the reactions RA and RG. We take minutes about one of the reactions to cipher the other, hence to happen RA: Take minutes about RG? Clockwise minutes (CM) = ? Anti-clockwise minutes (ACM)RA x 6 = 12 x 3RA = 6 kN now,? Upward Forces = ? Downward ForcesRA + RG = 126 + RG = 12

RG = 6 kN

subdivisionF +F -F -F +Calculating Shear Forces (we must utilize the shear force regulation) . When looking right of a subdivision: downward forces are positive and upward forces are negative. When looking left of a subdivision: downward forces are negative and upward forces are positive. Get downing at point A and looking left:(note: the negative mark (–) means merely to the left of the place and the positive mark (+) means merely to the right of the place.)SFA – = 0 kNSFA + = 6 kNAn alternate method of pulling the shear force diagram is to follow the waies of each force on the line diagram. SFB – = 6 kNSFB + = 6 kNSFC – = 6 kNSFC + = 6 kNSFD – = 6 kNSFD + = 6 – 12 = -6 kNSFE – = 6 – 12 = -6 kNSFE + = 6 – 12 = -6 kNSFF – = 6 – 12 = -6 kNSFF + = 6 – 12 = -6 kNSFG – = 6 – 12 = -6 kNSFG + = 6 – 12 + 6 = 0 kNNote: the shear force at either terminal of a merely supported beam must compare to zero.

Calculating Bending Moments (we must utilize the bending minute regulation) . When looking right of a subdivision: downward forces are negative and upward forces are positive. When looking left of a subdivision: downward forces are negative and upward forces are positive. subdivisionF -F -subdivisionF +F +Hoging Radio beamSaging Radio beamGet downing at point A and looking left: BMA = 0 kNmBMB = (6 x 1) = 6 kNmBMC = (6 x 2) = 12 kNmBMD = (6 x 3) = 18 kNmBME = (6 x 4) + (-12 x 1) = 12 kNmBMF = (6 x 5) + (-12 x 2) = 6 kNmBMG = (6 x 6) + (-12 x 3) = 0 kNmNote: the bending minute at either terminal of a merely supported beam must compare to zero. The undermentioned page shows the line, shear force and flexing minute diagrams for this beam.

Simply Supported Beam with Point Load

6 mFTocopherolCalciferolCGramBacillusA6 kN6 kNF = 12 kNShear Force Diagram (kN)00-660Line Diagram121218606Bending Moment Diagram (kNm)Max Tensile StressSAGGING (+ve bending)Max Compressive StressFFA maximal bending minute of 18 kNm occurs at place D. Note the shear force is zero at this point.

Simply Supported Beam with Distributed Load

UDL = 2 kN/mFTocopherolCalciferolCGramBacillusA6 mRAThe force from a UDL is considered to move at the UDL mid-point. e. g.

if we take minutes about ‘ D ‘ so the entire force from the UDL (looking to the left) would be: (2 x 3) = 6 kN. This force must be multiplied by the distance from point ‘ D ‘ to the UDL mid point as shown below. e. g.

Take minutes about ‘ D ‘ , so the minute would be: (-6 x 1. 5) = -9 kNm1. 5mUDL = 2 kN/mCalciferolCBacillusA3 mTaking minutes about point D (looking left)We must foremost cipher the reactions RA and RG. We take minutes about one of the reactions to cipher the other, hence to happen RA: Take minutes about RG? Clockwise minutes (CM) = ? Anti-clockwise minutes (ACM)RA x 6 = 2 ten 6 ten 3RA = 6 kN now,? Upward Forces = ? Downward ForcesRA + RG = 2 tens 66 + RG = 12

RG = 6 kN

subdivisionF +F -F -F +Calculating Shear Forces (we must utilize the shear force regulation) .

When looking right of a subdivision: downward forces are positive and upward forces are negative. When looking left of a subdivision: downward forces are negative and upward forces are positive. Get downing at point A and looking left:(note: the negative mark (–) means merely to the left of the place and the positive mark (+) means merely to the right of the place.)SFA – = 0 kNSFA + = 6 kNSFB – = 6 – (2×1) = 4 kNSFB + = 6 – (2×1) = 4 kNSFC – = 6 – (2×2) = 2 kNSFC + = 6 – (2×2) = 2 kNSFD – = 6 – (2×3) = 0 kNSFD + = 6 – (2×3) = 0 kNSFE – = 6 – (2×4) = -2 kNSFE + = 6 – (2×4) = -2 kNSFF – = 6 – (2×5) = -4 kNSFF + = 6 – (2×5) = -4 kNSFG – = 6 – (2×6) = -6 kNSFG + = 6 – (2×6) + 6 = 0 kNNote: the shear force at either terminal of a merely supported beam must compare to zero. Calculating Bending Moments (we must utilize the bending minute regulation) . When looking right of a subdivision: downward forces are negative and upward forces are positive. When looking left of a subdivision: downward forces are negative and upward forces are positive. subdivisionF -F -subdivisionF +F +Hoging Radio beamSaging Radio beamGet downing at point A and looking left: BMA = 0 kNmBMB = (6 x 1) + (-2 x 1 x 0.

5) = 5 kNmBMC = (6 x 2) + (-2 x 2 x 1) = 8 kNmBMD = (6 x 3) + (-2 x 3 x 1. 5) = 9 kNmBME = (6 x 4) + (-2 x 4 x 2) = 8 kNmBMF = (6 x 5) + + (-2 x 5 ten 2. 5 = 5 kNmBMG = (6 x 6) + + (-2 x 6 ten 3) = 0 kNmNote: the bending minute at either terminal of a merely supported beam must compare to zero. The undermentioned page shows the line, shear force and flexing minute diagrams for this beam.

Simply Supported Beam with Distributed Load

420-2-4UDL = 2 kN/m6 mFTocopherolCalciferolCGramBacillusAShear Force Diagram (kN)00-660Line Diagram88950Bending Moment Diagram (kNm)56 kN6 kNMax Tensile StressSAGGING (+ve bending)Max Compressive StressFFA maximal bending minute of 9 kNm occurs at place D. Note the shear force is zero at this point.

Simply Supported Beam with Point Loads

6 mFTocopherolCalciferolCGramBacillusARARoentgeniumF = 15 kNF = 30 kNWe must foremost cipher the reactions RA and RG. We take minutes about one of the reactions to cipher the other, hence to happen RA: Take minutes about RG? Clockwise minutes (CM) = ? Anti-clockwise minutes (ACM)RA x 6 = (15 x 4) + (30 x 2)RA = 20 kN now,? Upward Forces = ? Downward ForcesRA + RG = 15 + 3020 + RG = 45

RG = 25 kN

subdivisionF +F -F -F +Calculating Shear Forces (we must utilize the shear force regulation) .

When looking right of a subdivision: downward forces are positive and upward forces are negative. When looking left of a subdivision: downward forces are negative and upward forces are positive. Get downing at point A and looking left:(note: the negative mark (–) means merely to the left of the place and the positive mark (+) means merely to the right of the place.)SFA – = 0 kNSFA + = 20 kNSFB – = 20 kNSFB + = 20 kNSFC – = 20 kNSFC + = 20 -15 = 5 kNSFD – = 20 -15 = 5 kNSFD + = 20 -15 = 5 kNSFE – = 20 -15 = 5 kNSFE + = 20 -15 – 30 = -25 kNSFF – = 20 -15 – 30 = -25 kNSFF + = 20 -15 – 30 = -25 kNSFG – = 20 -15 – 30 = -25 kNSFG + = 20 -15 – 30 + 25 = 0 kNNote: the shear force at either terminal of a merely supported beam must compare to zero.

Calculating Bending Moments (we must utilize the bending minute regulation) . When looking right of a subdivision: downward forces are negative and upward forces are positive. When looking left of a subdivision: downward forces are negative and upward forces are positive. subdivisionF -F -subdivisionF +F +Hoging Radio beamSaging Radio beamGet downing at point A and looking left: BMA = 0 kNmBMB = (20 x 1) = 20 kNmBMC = (20 x 2) = 40 kNmBMD = (20 x 3) + (-15 x 1) = 45 kNmBME = (20 x 4) + (-15 x 2) = 50 kNmBMF = (20 x 5) + (-15 x 3) + (-30 x 1) = 25 kNmBMG = (20 x 6) + (-15 x 4) + (-30 x 2) = 0 kNmNote: the bending minute at either terminal of a merely supported beam must compare to zero.

The undermentioned page shows the line, shear force and flexing minute diagrams for this beam.

0

20

-25

0

Shear Force Diagram (kN)

5Simply Supported Beam with Point Loads

6 mFTocopherolCalciferolCGramBacillusA20 kN25 kNF = 15 kNF = 30 kNBending Moment Diagram (kNm)004540205025Max Tensile

StressSAGGING (+ve bending)Max Compressive StressFFA maximal bending minute of 50 kNm occurs at place E. Note the shear force is zero at this point.

Simply Supported Beam with Point and Distributed Loads (1)

6 mFTocopherolCalciferolCGramBacillusARARoentgenium15 kN30 kNUDL = 10 kN/mWe must foremost cipher the reactions RA and RG. We take minutes about one of the reactions to cipher the other, hence to happen RA: Take minutes about RG? Clockwise minutes (CM) = ? Anti-clockwise minutes (ACM)RA x 6 = (15 x 4) + (10 x 2 ten 3) + (30 x 2)RA = 30 kN now,? Upward Forces = ? Downward ForcesRA + RG = 15 + (10 x 2) + 3030 + RG = 65

RG = 35 kN

subdivisionF +F -F -F +Calculating Shear Forces (we must utilize the shear force regulation) .

When looking right of a subdivision: downward forces are positive and upward forces are negative. When looking left of a subdivision: downward forces are negative and upward forces are positive. Get downing at point A and looking left:(note: the negative mark (–) means merely to the left of the place and the positive mark (+) means merely to the right of the place.)SFA – = 0 kNSFA + = 30 kNSFB – = 30 kNSFB + = 30 kNSFC – = 30 kNSFC + = 30 – 15 = 15 kNSFD – = 30 – 15 – (10 x 1) = 5 kNSFD + = 30 – 15 – (10 x 1) = 5 kNSFE – = 30 – 15 – (10 x 2) = -5 kNSFE + = 30 – 15 – (10 x 2) – 30 = -35 kNSFF – = 30 – 15 – (10 x 2) – 30 = -35 kNSFF + = 30 –

15 – (10 x 2) – 30 = -35 kNSFG – = 30 – 15 – (10 x 2) – 30 = -35 kNSFG + = 30 – 15 – (10 x 2) – 30 + 35 = 35 kNNote: the shear force at either terminal of a merely supported beam must compare to zero. Calculating Bending Moments (we must utilize the bending minute regulation) . When looking right of a subdivision: downward forces are negative and upward forces are positive.

When looking left of a subdivision: downward forces are negative and upward forces are positive. subdivisionF -F -subdivisionF +F +Hoging Radio beamSaging Radio beamGet downing at point A and looking left: BMA = 0 kNmBMB = (30 x 1) = 30 kNmBMC = (30 x 2) = 60 kNmBMD = (30 x 3) + (-15 x 1) + (-10 x 1 x 0. 5) = 70 kNmBME = (30 x 4) + (-15 x 2) + (-10 x 2 x 1) = 70 kNmBMF = (30 x 5) + (-15 x 3) + (-10 x 2 x 2) + (-30 x 1) = 35 kNmBMG = (30 x 6) + (-15 x 4) + (-10 x 2 x 3) + (-30 x 2) = 0 kNmNotes: the bending minute at either terminal of a merely supported beam must compare to zero. The value of the maximal bending minute occurs where the shear force is zero and is hence still unknown (see Shear Force diagram) . The distance from point A to this nothing SF point must be determined as follows: -ten = 215 20ten = 1. 5 m Entire distance from point A = 2 + 1. 5 = 3. 5 mhence, BM soap = (30 x 3.

5) + (-15 x 1. 5) + (-10 X 1. 5 x 0. 75) = 71. 25 kNmThe undermentioned page shows the line, shear force and flexing minute diagrams for this beam. 7071.

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Simply Supported Beam with Point and Distributed Loads (1)

2 mten30-5Shear Force Diagram (kN)0-351506 mFTocopherolCalciferolCGramBacillusA30 kN35 kN15 kN30 kNUDL = 10 kN/m20 kNBending Moment Diagram (kNm)Max Tensile StressSAGGING (+ve bending)Max Compressive StressFFA maximal bending minute of 71. 25 kNm occurs at a distance 3. 5 m from place A.

Simply Supported Beam with Point and Distributed Loads (2)

1 mRubidium12 mTocopherolCalciferolCFBacillusA8 kNRheniumUDL = 6 kN/mUDL = 4 kN/m12 kNWe must foremost cipher the reactions RB and RE. We take minutes about one of the reactions to cipher the other, hence to happen RB. Take minutes about RE? Clockwise minutes (CM) = ? Anti-clockwise minutes (ACM)(RBx10) + (6x1x0.

5) = (4 x 4 ten 9) + (8 x 7) + (12 x 3) + (6 x 3 ten 1. 5)

RB = 26 kN

now,? Upward Forces = ? Downward ForcesRB + RE = (4 x 4) + 8 + 12 + (6 x 4)26 + RE = 60

RE = 34 kN

Calculating Shear Forces

Get downing at point A and looking left: SFA – = 0 kNSFA + = 0 kNSFB – = -4 x 1 = -4 kNSFB + = (-4 x 1) + 26 = 22 kNSFC – = (-4 x 4) + 26= 10 kNSFC + = (-4 x 4) + 26 – 8 = 2 kNSFD – = (-4 x 4) + 26 – 8 = 2 kNSFD + = (-4 x 4) + 26 – 8 – 12 = -10 kNSFE – = (-4 x 4) + 26 – 8 – 12 – (6 x 3) = -28 kNSFE + = (-4 x 4) + 26 – 8 – 12 – (6 x 3) + 34 = 6 kNSFF – = (-4 x 4) + 26 – 8 – 12 – (6 x 4) + 34 = 0 kNSFF + = (-4 x 4) + 26 – 8 – 12 – (6 x 4) + 34 = 0 kN

Calculating Bending Moments

Get downing at point A and looking left: BMA = 0 kNmBMB = (-4 x 1 ten 0. 5) = -2 kNmBM 2m from A = (-4 x 2 ten 1) + (26 x 1) = 18 kNmBM 3m from A = (-4 x 3 ten 1. 5) + (26 x 2) = 34 kNmBMC = (-4 x 4 ten 2) + (26 x 3) = 46 kNmBMD = (-4 x 4 ten 6) + (26 x 7) + (-8 x 4) = 54 kNmBM 9m from A = (-4 x 4 ten 7) + (26 x 8) + (-8 x 5) + (-12 x 1) +(-6 x 1 ten 0. 5) = 41 kNmBM 9m from A = (-4 x 4 ten 8) + (26 x 9) + (-8 x 6) + (-12 x 2) +(-6 x 2 ten 1) = 22 kNmBME = (-4 x 4 ten 9) + (26 x 10) + (-8 x 7) + (-12 x 3) +(-6 x 3 ten 1. 5) = -3 kNmBMF = (-4 x 4 ten 10) + (26 x 11) + (-8 x 8) + (-12 x 4) +(-6 x 4 ten 2) + (34 x 1) = 0 kNm

Point of Contraflexure

At any point where the graph on a bending minute diagram passes through the 0-0 data point line (i. e. where the BM alterations mark) the curvature of the beam will alter from hogging to drooping or frailty versa.

Such a point is termed a Point of Contraflexure or Inflexion. These points are identified in the undermentioned diagram. It should be noted that the point of contraflexure corresponds to zero flexing minute.

Turning Points

The mathematical relationship between shear force and matching flexing minute is evidenced on their several graphs where the alteration of incline on a BM diagram aligns with zero shear on the complementary shear force diagram. Therefore, at any point on a BM diagram where the incline alterations way from upwards to downwards or frailty versa, all such Turning Points occur at places of Zero Shear.

Turning points are besides identified in the undermentioned diagram.

Simply Supported Beam with Point and Distributed Loads (2)

1 m26 kN12 mTocopherolCalciferolCFBacillusA8 kN34 kNUDL = 6 kN/mUDL = 4 kN/m12 kN262-422-10Shear Force Diagram (kN)0-28100FFSAGGING (+ve bending)-3224154463418-2Bending Moment Diagram (kNm)00FFHOGGING (-ve bending)Points of ContraflexureThe maximal bending minute is equal to 54 kNm and occurs at point D where the shear force is zero. Turning points occur at -2 kNm and -3 kNm.

Cantilever Beam with Point Load

6 mFTocopherolCalciferolCGramBacillusARA12 kNFree EndFixed EndIn this instance there is merely one unknown reaction at the fixed terminal of the cantilever, therefore:? Upward Forces = ? Downward Forces

RA = 12 kN

Calculating Shear Forces –

Get downing at point A and looking left: SFA – = 0 kNSFA + = 12 kNSFB – = 12 kNSFB + = 12 kNSFC – = 12 kNSFC + = 12 kNSFD – = 12 kNSFD + = 12 kNSFE – = 12 kNSFE + = 12 kNSFF – = 12 kNSFF + = 12 kNSFG – = 12 kNSFG + = 12 – 12 = 0 kNNote: the shear force at either terminal of a cantilever beam must compare to zero.

Calculating Bending Moments – Niobium for simpleness at this phase we shall ever look towards the free terminal of the beam.

Get downing at fixed terminal, point A, and looking right towards the free terminal:(the same consequences may be obtained by get downing at point G and looking right)BMA = -12 x 6 = -72 kNmBMB = -12 x 5 = -60 kNmBMC = -12 x 4 = -48 kNmBMD = -12 x 3 = -36 kNmBME = -12 x 2 = -24 kNmBMF = -12 x 1 = -12 kNmBMG = 0 kNmNotes: the maximal bending minute in a cantilever beam occurs at the fixed terminal.

In this instance the 12kN force in the beam is seeking to flex it downwards, (a clockwise minute) . The support at the fixed terminal must hence be using an equal but opposite minute to the beam. This would be 72 kNm in an anti-clockwise way. See the undermentioned diagram. The value of the bending minute at the free terminal of a cantilever beam will ever be zero.-12-24-36-48-60-72Bending Moment Diagram (kNm)0012125Shear Force Diagram (kN)0072 kNm72 kNm6 mFTocopherolCalciferolCGramBacillusA12 kN12 kNThe followers shows the line, shear force and flexing minute diagrams for this beam. FFHOGGING (-ve bending)Max Tensile StressMax Compressive StressA maximal bending minute of -72 kNm occurs at place A.

Cantilever Beam with Distributed Load

UDL = 2 kN/m6 mFTocopherolCalciferolCGramBacillusARATo cipher the unknown reaction at the fixed terminal of the cantilever:? Upward Forces = ? Downward ForcesRA = 2 tens 6

RA = 12 kN

Calculating Shear Forces

Get downing at point A and looking left: SFA – = 0 kNSFA + = 12 kNSFB – = 12 – (2 x 1) = 10 kNSFB + = 12 – (2 x 1) = 10 kNSFC – = 12 – (2 x 2) = 8 kNSFC + = 12 – (2 x 2) = 8 kNSFD – = 12 – (2 x 3) = 6 kNSFD + = 12 – (2 x 3) = 6 kNSFE – = 12 – (2 x 4) = 4 kNSFE + = 12 – (2 x 4) = 4 kNSFF – = 12 – (2 x 5) = 2 kNSFF + = 12 – (2 x 5) = 2 kNSFG – = 12 – (2 x 6) = 0 kNSFG + = 12 – (2 x 6) = 0 kNNote: the shear force at either terminal of a cantilever beam must compare to zero.

Calculating Bending Moments

Get downing at fixed terminal, point A, and looking right towards the free terminal:(the same consequences may be obtained by get downing at point G and looking right)BMA = -2 x 6 ten 3 = -36 kNmBMB = -2 x 5 ten 2. 5 = -25 kNmBMC = -2 x 4 ten 2 = -16 kNmBMD = -2 x 3 ten 1. 5 = -9 kNmBME = -2 x 2 ten 1 = -4 kNmBMF = -2 x 1 ten 0. 5 = -1 kNmBMG = 0 kNmThe undermentioned page shows the line, shear force and flexing minute diagrams for this beam. Cantilever Beam with Distributed Load864236 kNm36 kNm12105Shear Force Diagram (kN)00-1-4-9-16-25-36Bending Moment Diagram (kNm)006 mFTocopherolCalciferolCGramBacillusA12 kNUDL = 2 kN/mFFHOGGING (-ve bending)Max Tensile StressMax Compressive StressA maximal bending minute of -36 kNm occurs at place A.

Cantilever Beam with Point and Distributed Loads

Roentgenium2 m10 kNBacillusCCalciferolTocopherolAFGram4 mUDL = 10 kN/mTo cipher the unknown reaction at the fixed terminal of the cantilever:? Upward Forces = ? Downward ForcesRG = (10 x 6) + 10

RG = 70 kN

Calculating Shear Forces

Get downing at point A and looking left: SFA – = 0 kNSFA + = 0 kNSFB – = -10 x 1 = -10 kNSFB + = -10 x 1 = -10 kNSFC – = -10 x 2 = -20 kNSFC + = (-10 x 2) + (-10) = -30 kNSFD – = (-10 x 3) + (-10) = -40 kNSFD + = (-10 x 3) + (-10) = -40 kNSFE – = (-10 x 4) + (-10) = -50 kNSFE + = (-10 x 4) + (-10) = -50 kNSFF – = (-10 x 5) + (-10) = -60 kNSFF + = (-10 x 5) + (-10) = -60 kNSFG – = (-10 x 6) + (-10) = -70 kNSFG + = (-10 x 6) + (-10) + 70 = 0 kNNote: the shear force at either terminal of a cantilever beam must compare to zero.

Calculating Bending Moments

Get downing at point A, and looking left from the free terminal:(the same consequences may be obtained by get downing at point G and looking left)BMA = 0 kNmBMB = -10 x 1 ten 0. 5 = -5 kNmBMC = -10 x 2 ten 1 = -20 kNmBMD = (-10 x 3 ten 1. 5) + (-10 x 1) = -55 kNmBME = (-10 x 4 ten 2) + (-10 x 2) = -100 kNmBMF = (-10 x 5 ten 2. 5) + (-10 x 3) = -155 kNmBMG = (-10 x 6 ten 3) + (-10 x 4) = -220 kNmThe undermentioned page shows the line, shear force and flexing minute diagrams for this beam.

70 kN2 m10 kNBacillusCCalciferolTocopherolAFGram4 mUDL = 10 kN/m

0

0

Shear Force Diagram (kN)

-60

-70

-10

-20

-40

-50

220 kNm

220 kNm

-30Cantilever Beam with Point and Distributed Loads

00Bending Moment Diagram (kNm)-220-5-20-55-100-155FFHOGGING (-ve bending)Max Tensile StressMax Compressive StressA maximal bending minute of -220 kNm occurs at place G.