DELFT APPLIED MECHANICS COURSE AE1-914 PART I: STATICS

15 rules for the quick statement of internal force diagrams

Source: HARTSUIJKER, C. (1999), *Toegepaste mechanica deel 1: Evenwicht,* Academic Service, Schoonhoven

Rule 1

If a segment has no distributed load then the shear force V is constant and the bending moment M is linear. If the shear force is zero then the bending moment is constant.

$$q = 0 \Rightarrow V \text{ constant}; \quad \begin{array}{l} V = 0 \Rightarrow M \text{ constant} \\ V \neq 0 \Rightarrow M \text{ linear} \end{array}$$

Rule 2

In a segment with constant distributed load q the shear force V is linear and the bending moment M is quadratic.

$$q \text{ constant}(\neq 0) \Rightarrow V \text{ linear} \Rightarrow M \text{ quadratic}$$

Rule 3

In a segment with linear distributed load q the shear force V is quadratic and the bending moment M is cubic.

$$q \text{ linear} \Rightarrow V \text{ quadratic} \Rightarrow M \text{ cubic}$$

Rule 4

The slope of the V-diagram (dV/dx) equals the distributed load q (with opposite sign).

Rule 5

The slope of the M-diagram (dM/dx) equals the shear force V.

Rule 6

The shear force V is extreme where the distributed load q is zero or changes of sign. There can be extremes at the boundaries of a segment, e.g. where point loads or supports are present.

Rule 7

The bending moment M is extreme where the shear force V is zero or changes of sign. There can be extremes at the boundaries of a segment, e.g. where point loads or moments are applied or fixed supports are present.

Rule 8

The tangent lines to the M-diagram at the boundaries of a segment cut each other on the line of action of the resultant of the loads applied to that segment.

Rule 9

If the loads of a segment are replaced by their resultant, the bending moment diagram which results from this resultant is tangent to the actual bending moment diagram at the boundaries of the segment.

Rule 10

The change of the shear force V along a given length is equal to the area below the load diagram along the same length, with opposite sign (this is valid only when no point loads are applied within the considered length).

Rule 11

The change of the bending moment M along a given length is equal to the area below the V-diagram along the same length (this is valid only when no point moments are applied within the considered length).

Rule 12

The total area enclosed by the V-diagram equals the sum of point moments applied to the beam. If no point moments are applied to a beam, the total area enclosed by the V-diagram is zero.

Rule 13

A jump in the distributed load q provides a kink in the V-diagram and an inflection in the M-diagram.

Rule 14

A point load F perpendicular to the beam axis provides a jump of magnitude F in the V-diagram and a kink in the M-diagram.

Rule 15

A point moment T provides a jump of magnitude T in the M-diagram. The V-diagram remains unaltered.

Rule 16

When a beam is loaded by forces perpendicular to the beam axis, the M-diagram has the same shape as a cable loaded by the same forces.