Blueprints

Blueprints

May 14, 2024

CONTENTS

Welcome to the `Blueprints` API Reference.

blueprints.codes	Codes package.
blueprints.type_alias	Module to keep track of type aliases used in Blueprints.
blueprints.unit_conversion	Module for unit conversions inside of Blueprints.
blueprints.validations	Module for validation actions inside of Blueprints.

CHAPTER

ONE

CODES

Codes package.

blueprints.codes.cur	CUR package.
blueprints.codes.eurocode	Eurocodes package.
blueprints.codes.formula	Module for the abstract base class Formula.
blueprints.codes.latex_formula	Latex formula representation.

1.1 cur

CUR package.

blueprints.codes.cur.cur_166	CUR-166 package.

1.1.1 cur_166

CUR-166 package.

1.2 eurocode

Eurocodes package.

blueprints.codes.eurocode.nen_9997_1_c2_2017	NEN 9997-1-C2:2017.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011	Eurocode NEN-EN 1992-1-1+C2:2011.
blueprints.codes.eurocode.nen_en_1993_1_1_c2_a1_2016	NEN-EN 1993-1-1+C2+A1:2016.
blueprints.codes.eurocode.nen_en_1993_5_2008	NEN-EN 1993-5:2008.

1.2.1 nen_9997_1_c2_2017

NEN 9997-1-C2:2017.

blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_1_general_rules	Package representing the formulas chapter 1 from NEN-EN 1997-1:2017.
blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_2_basic_of_geotechnical_design	Package contains the formulas from chapter 2: Basic of geotechnical design of NEN 9997-1+C2:2017.

chapter_1_general_rules

Package representing the formulas chapter 1 from NEN-EN 1997-1:2017.

blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_1_general_rules.formula_1_0_1	Formula 1.0.1 from NEN 9997-1+C2:2017: Chapter 1: General rules.

formula_1_0_1

Formula 1.0.1 from NEN 9997-1+C2:2017: Chapter 1: General rules.

`class blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_1_general_rules.formula_1_0_1.`**`Form1Dot0Dot1E`**

Bases: *Formula*

Class representing formula 1.0.1 for the calculation of the equivalent pile point centerline D_{eq} in [m].

`label = '1.0.1'`

`source_document = 'NEN 9997-1-C2:2017'`

`__init__`(*a: float*, *b: float*) → None

[D_{eq}] Equivalent pile point centerline.

NEN 9997-1+C2:2017 art.1.5.2.106a - Formula (1.0.1)

Parameters

a

[M] [a] minor dimension of the largest cross-section at the pile tip [m].

b

[M] [b] major dimension of the largest cross-section at the pile tip [m].

Where: b 1.5 * a

latex() → *LatexFormula*

Returns LatexFormula object for formula 1.0.1.

Return type
LatexFormula

chapter_2_basic_of_geotechnical_design

Package contains the formulas from chapter 2: Basic of geotechnical design of NEN 9997-1+C2:2017.

blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_2_basic_of_geotechnical_design.formula_2_1_a	Formula 2.1a from NEN 9997-1+C2:2017: Chapter 2: Basis of geotechnical design.
blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_2_basic_of_geotechnical_design.formula_2_1_b	Formula 2.1b from NEN 9997-1+C2:2017: Chapter 2: Basis of geotechnical design.
blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_2_basic_of_geotechnical_design.formula_2_2	Formula 2.2 from NEN 9997-1+C2:2017: Chapter 2: Basis of geotechnical design.

formula_2_1_a

Formula 2.1a from NEN 9997-1+C2:2017: Chapter 2: Basis of geotechnical design.

class blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_2_basic_of_geotechnical_design.formula_2_1_a

Bases: *Formula*

Class representing formula 2.1a for the calculation of the design value F_d of actions.

label = '2.1a'

source_document = 'NEN 9997-1-C2:2017'

__init__(*gamma_f: float*, *f_rep: float*) → None

[F_d] Design value of actions.

NEN 9997-1+C2:2017 art.2.4.6.1(2) - (Formula 2.1a)

Parameters

gamma_f
: [DIMENSIONLESS] [$_F$] partial factor for actions for persistent and transient situations defined in annex A [-].

f_rep
: [float] [F_{rep}] Representative value of actions.

  Use your own implementation for this value or use `Form2Dot1bRepresentativeValue`.

formula_2_1_b

Formula 2.1b from NEN 9997-1+C2:2017: Chapter 2: Basis of geotechnical design.

`class blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_2_basic_of_geotechnical_design.formula_2_1_b`

Bases: *Formula*

Class representing formula 2.1b for the calculation of the representative value F_{rep} of actions.

label = '2.1b'

source_document = 'NEN 9997-1-C2:2017'

__init__(*psi: float*, *f_k: float*) → None

[F_{rep}] Representative value of actions.

NEN 9997-1+C2:2017 art.2.4.6.1(2) - Formula (2.1b)

Parameters

psi
: [DIMENSIONLESS] [] factor for converting the characteristic value to the representative value [-].

f_k
: [float] [F_k] Characteristic value of actions.

formula_2_2

Formula 2.2 from NEN 9997-1+C2:2017: Chapter 2: Basis of geotechnical design.

`class blueprints.codes.eurocode.nen_9997_1_c2_2017.chapter_2_basic_of_geotechnical_design.formula_2_2.F`

Bases: *Formula*

Class representing formula 2.2 for the calculation of the design value X_d of geotechnical parameter X.

`label = '2.2'`

`source_document = 'NEN 9997-1-C2:2017'`

`__init__`(*x_k: float*, *gamma_m: float*) → None

[X_d] Design value of geotechnical parameter [X].

NEN 9997-1+C2:2017 art.2.4.6.2(1) - Formula (2.2)

Parameters

x_k
[float] [X_k] Characteristic value of geotechnical parameter [X].

gamma_m
[DIMENSIONLESS] [$gamma_M$] material partial factor [-].

`latex`() → *LatexFormula*

Returns LatexFormula object for formula 2.2.

Return type
LatexFormula

1.2.2 nen_en_1992_1_1_c2_2011

Eurocode NEN-EN 1992-1-1+C2:2011.

blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_10_precast_concrete_elements_and_st	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 10 - Additional rules for precast concrete elements and structures.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_11_lightweight_aggregate_concrete_s	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 11 - Lightweight aggregate concrete structures.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_12_plain_and_lightly_reinforced_con	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 12 - Plain and lightly reinforced concrete structures.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_3_materials	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_4_durability_and_cover	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 4 - Durability and cover to reinforcement.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_5_structural_analysis	Module containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_6_ultimate_limit_state	Module containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 6 - Ultimate limit state.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_7_serviceability_limit_state	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 7 - Serviceability Limit States (SLS).
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 8 - Detailing of reinforcement and prestressing tendons - General.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_9_detailling_and_specific_rules	Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

chapter_10_precast_concrete_elements_and_structures

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 10 - Additional rules for precast concrete elements and structures.

chapter_11_lightweight_aggregate_concrete_structures

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 11 - Lightweight aggregate concrete structures.

chapter_12_plain_and_lightly_reinforced_concrete_structures

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 12 - Plain and lightly reinforced concrete structures.

chapter_3_materials

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_1	Formula 3.1 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_10	Formula 3.10 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_11	Formula 3.11 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_12	Formula 3.12 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_13	Formula 3.13 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_14	Formula 3.14 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_15	Formula 3.15 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_16	Formula 3.16 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_17	Formula 3.17 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_18	Formula 3.18 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_19_20	Formula 3.19 and 3.20 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_2	Formula 3.2 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_21_22	Formula 3.21 and 3.22 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_23	Formula 3.23 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_24	Formula 3.24 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_25	Formula 3.25 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_26	Formula 3.26 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_27	Formula 3.27 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_28	Formula 3.28 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.	Formula 3.29 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

formula_3_1

Formula 3.1 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_1.**Form3Dot1Estima**

Bases: *Formula*

Class representing formula 3.1 for the estimation of the concrete compressive strength, fcm(t), after t days with an average temperature of 20 degrees Celsius.

label = '3.1'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*beta_cc_t: float*, *f_cm: float*) → None

[fcm(t)] The estimated concrete compressive strength [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.2(6) - Formula (3.1)

Parameters

beta_cc_t
[float] [cc(t)] Coefficient dependent of the age of concrete [-].

f_cm
[MPA] [fcm] Average concrete compressive strength on day 28 based on table 3.1 [MPa].

Returns

None

formula_3_10

Formula 3.10 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_10.**Form3Dot10Coef**

Bases: *Formula*

Class representing formula 3.10 for the calculation of the coefficient for drying shrinkage due to age.

label = '3.10'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*t: float*, *t_s: float*, *h_0: float*) → None

[ds(t,ts)] Coefficient for drying shrinkage due to age of concrete [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(6) - Formula (3.10)

Parameters

t
[DAYS] [t] Age in days of the concrete at the considered moment [days].

t_s
[DAYS] [t] Age in days of the concrete at the start of the drying shrinkage [days].

h_0
[MM] [h0] fictional thickness of cross-section [mm]. = 2 * Ac / u Use your own implementation of this formula or use the SubForm3Dot10FictionalCrossSection class.

Returns

None

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_10.**SubForm3Dot10F**

Bases: *Formula*

Class representing sub-formula for formula 3.10 for the calculation of fictional thickness of the cross-section.

label = '3.10'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*a_c: float*, *u: float*) → None

[h0] Fictional thickness of the cross-section [mm].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(6) - h0

Parameters

a_c
[MM2] [Ac] Area of the cross-section of the concrete [mm^2].

u
[MM] [u] Circumference of part that is subjected to drying [mm].

formula_3_11

Formula 3.11 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_11.**Form3Dot11Autog**

Bases: *Formula*

Class representing formula 3.11, which calculates the autogene shrinkage.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '3.11'

__init__(*beta_as_t: float*, *epsilon_ca_inf: float*) → None

[ca(t)] Autogene shrinkage [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(6) - Formula (3.11)

Parameters

beta_as_t
[float] [as(t)] Coefficient dependent on time in days for autogene shrinkage [-]. = 1 - exp(-0.2 * t^0.5) Use your own implementation of this formula or use the Form3Dot13CoefficientTimeAutogeneShrinkage class

epsilon_ca_inf
[float] [ca(∞)] Autogene shrinkage at infinity [-]. = 2.5 * (fck - 10) E-6 Use your own implementation of this formula or use the Form3Dot12AutogeneShrinkageInfinity class.

Returns

None

formula_3_12

Formula 3.12 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_12.Form3Dot12Autog`

Bases: `Formula`

Class representing formula 3.12, which calculates the autogene shrinkage at infinity.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '3.12'

__init__(*f_ck: float*) → None

[ca(∞)] Autogene shrinkage at infinity [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(6) - Formula (3.12)

Parameters

f_ck
[MPA] [fck] Compressive strength concrete [MPa].

Returns

None

formula_3_13

Formula 3.13 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_13.**Form3Dot13Coef**

Bases: *Formula*

Class representing formula 3.13, which calculates the coefficient dependent on time for the autogene shrinkage.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '3.13'

__init__(*t: float*) → None

[as(t)] Coefficient dependent on time in days for autogene shrinkage [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(6) - Formula (3.13)

Parameters

t
[DAYS] [t] Time in days [days].

Returns

None

formula_3_14

Formula 3.14 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_14.**Form3Dot14Stre**

Bases: *Formula*

Class representing formula 3.14, which calculates the compressive stress-strength ratio.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '3.14'

__init__(*k: float*, *eta: float*) → None

[c / fcm] Compressive stress-strength ratio [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.5(1) - Formula (3.14)

Parameters

k

[float] [k] [-]. = 1.05 * Ecm * **|c1|** / fcm Use your own implementation of this formula or use the SubForm3Dot14K class.

eta

[float] [] Strain - peak-strain ratio [-]. = c / c1 Use your own implementation of this formula or use the SubForm3Dot14Eta class.

Returns

None

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_14.**SubForm3Dot14E**

Bases: *Formula*

Class representing sub-formula 1 for formula 3.14, which calculates eta.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '3.14'

__init__(*epsilon_c: float*, *epsilon_c1: float*) → None

[] Strain - peak-strain ratio [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.5(1) -

Parameters

epsilon_c

[float] [c] Strain concrete [-].

epsilon_c1

[float] [c1] Strain concrete at peak-stress following table 3.1 [-].

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_14.**SubForm3Dot14K**

Bases: *Formula*

Class representing sub-formula 2 for formula 3.14, which calculates k.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '3.14'

__init__(*e_cm: float*, *epsilon_c1: float*, *f_cm: float*) → None

[k] [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.5(1) - k

Parameters

e_cm
[MPA] [Ecm] Elastic modulus concrete [MPa].

epsilon_c1
[float] [c1] Strain concrete at peak-stress following table 3.1 [-].

f_cm
[MPA] [fcm] Compressive strength concrete [MPa].

formula_3_15

Formula 3.15 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_15.**Form3Dot15Desi**

Bases: *Formula*

Class representing formula 3.15 for the calculation of the concrete compressive strength design value.

label = '3.15'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*alpha_cc: float*, *f_ck: float*, *gamma_c: float*) → None

[fcd] Design value concrete compressive strength [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.6(1) - Formula (3.15)

Parameters

alpha_cc
[float] [cc] Coefficient taking long term effects on compressive strength into account and unfavorable effect due to positioning loading [-] Normally between 0.8 and 1, see national appendix. Recommended value: 1.0

f_ck
[MPA] [fck] Characteristic compressive strength [MPa].

gamma_c
[float] [c] Partial safety factor concrete, see 2.4.2.4 [-].

Returns

None

formula_3_16

Formula 3.16 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_16.`**`Form3Dot16Desi`**

Bases: *Formula*

Class representing formula 3.16 for the calculation of the concrete tensile strength design value.

`label = '3.16'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*alpha_ct: float*, *f_ctk_0_05: float*, *gamma_c: float*) → None
[fcd] Design value concrete tensile strength [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.6(2) - Formula (3.16)

Parameters

alpha_ct
[float] [ct] Coefficient taking long term effects on tensile strength into account and unfavorable effect due to positioning loading [-] See national appendix. Recommended value: 1.0

f_ctk_0_05
[MPA] [fctk,0,05] Characteristic tensile strength 5% [MPa].

gamma_c
[float] [c] Partial safety factor concrete, see 2.4.2.4 [-].

Returns

None

formula_3_17

Formula 3.17 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_17.**Form3Dot17Comp**

Bases: *Formula*

Class representing formula 3.17 for the calculation of compressive stress in concrete using stress-strain diagram of figure 3.3.

label = '3.17'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_cd: float*, *epsilon_c: float*, *epsilon_c2: float*, *n: float*) → None

[c] Compressive stress in concrete using stress-strain diagram of figure 3.3 [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.7(1) - Formula (3.17)

Parameters

f_cd
[MPA] [fcd] Design value compressive strength concrete [MPa].

epsilon_c
[float] [c] Strain in concrete [-].

epsilon_c2
[float] [c2] Strain in concrete when reaching maximum strength following table 3.1 [-].

n
[float] Exponent following table 3.1.

Returns

None

formula_3_18

Formula 3.18 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_18.**Form3Dot18Comp**

Bases: *Formula*

Class representing formula 3.18 for the calculation of compressive stress in concrete using stress-strain diagram of figure 3.3.

label = '3.18'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_cd: float*) → None

[c] Compressive stress in concrete using stress-strain diagram of figure 3.3 [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.7(1) - Formula (3.18)

Parameters

f_cd
[MPA] [fcd] Design value compressive strength concrete [MPa].

Returns

None

formula_3_19_20

Formula 3.19 and 3.20 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_19_20.**Form3Dot19A**

Bases: *Formula*

Class representing formula 3.19 and 3.20 for the calculation of the factor for the effective pressure zone height.

label = '3.19 - 3.20'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_ck: float*) → None

[] Factor effective pressure zone height [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.7(3) - Formula (3.19) and (3.20)

Parameters

f_ck
[MPA] [fck] Characteristic compressive strength concrete [MPa]. Valid range: f_ck <= 90.

Returns

None

formula_3_2

Formula 3.2 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_2.**Form3Dot2Coeffi**

Bases: *Formula*

Class representing formula 3.2 for the coefficient cc(t) which is dependent of the age of concrete.

label = '3.2'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*s: float*, *t: float*) → None

Calculates beta_cc(t) coefficient which is dependent of the age of concrete in days [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.2(6) - Formula (3.2)

Parameters

s
[float] [s] Coefficient dependent on the kind of cement [-]. = 0.20 for cement of strength classes CEM 42.5 R, CEM 52.5 N, and CEM 52.5 R (class R); = 0.25 for cement of strength classes CEM 32.5 R, CEM 42.5 N (class N); = 0.38 for cement of strength class CEM 32.5 N (class S). Use your own implementation of this formula or use the SubForm3Dot2CoefficientTypeOfCementS class.

t
[DAYS] [t] Age of concrete in days [days].

Returns

None

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_2.**SubForm3Dot2Coe**

Bases: *Formula*

Class representing sub-formula for formula 3.2, which calculates the coefficient 's' which is dependent on the cement class.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '3.2'

__init__(*cement_class: str*) → None

[s] Coefficient that depends on the type of cement [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.2(6) - s

Parameters

cement_class

[str]

[cement_class] Class of the cement.

= 'R' for cement of strength classes CEM 42.5 R, CEM 52.5 N, and CEM 52.5 R (class R); = 'N' for cement of strength classes CEM 32.5 R, CEM 42.5 N (class N); = 'S' for cement of strength class CEM 32.5 N (class S).

formula_3_21_22

Formula 3.21 and 3.22 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_21_22.**Form3Dot21Ar**

Bases: *Formula*

Class representing formula 3.21 and 3.22 for the calculation of the factor for the effective strength.

label = '3.21 - 3.22'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_ck: float*) → None

[] Factor effective strength [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.7(3) - Formula (3.21) and (3.22)

Parameters

f_ck

[MPA] [fck] Characteristic compressive strength concrete [MPa]. Valid range: f_ck <= 90.

Returns

None

formula_3_23

Formula 3.23 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_23.**Form3Dot23Flexu**

Bases: *Formula*

Class representing formula 3.23 for the calculation of the mean flexural tensile strength of reinforced concrete members.

label = '3.23'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*h: float*, *f_ctm: float*) → None

[fctm,fl] Mean flexural tensile strength of reinforced concrete members [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.8(1) - Formula (3.23)

Parameters

h
[MM] [h] Total member depth [mm].

f_ctm
[MPA] [fctm] Mean axial tensile strength following from table 3.1 [MPa].

Returns

None

formula_3_24

Formula 3.24 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_24.**Form3Dot24Incre**

Bases: *Formula*

Class representing formula 3.24 for the calculation of the increased characteristic compressive strength due to enclosed concrete.

```
label = '3.24'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

__init__(*f_ck: float*, *sigma_2: float*) → None

[fck,c] Increased characteristic compressive strength due to enclosed concrete [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.9(2) - Formula (3.24)

Parameters

f_ck
[MPA] [fck] Characteristic compressive strength [MPa]

sigma_2
[MPA] [2] Effective compressive stress in transverse direction [MPa] 2 <= 0.05 * fck

Returns

None

formula_3_25

Formula 3.25 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_25.Form3Dot25Incr
```

Bases: `Formula`

Class representing formula 3.25 for the calculation of the increased characteristic compressive strength due to enclosed concrete.

```
label = '3.25'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

__init__(*f_ck: float*, *sigma_2: float*) → None

[fck,c] Increased characteristic compressive strength due to enclosed concrete [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.9(2) - Formula (3.25)

Parameters

f_ck
[MPA] [fck] Characteristic compressive strength [MPa]

sigma_2
[MPA] [2] Effective compressive stress in transverse direction [MPa] 2 > 0.05 * fck

Returns

None

formula_3_26

Formula 3.26 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_26.`**`Form3Dot26Incre`**

Bases: *`Formula`*

Class representing formula 3.26 for the calculation of the increased strain at the maximum strength due to enclosed concrete.

`label = '3.26'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*f_ck: float*, *f_ck_c: float*, *epsilon_c2: float*) → None

[c2,c] Increased strain at the maximum strength due to enclosed concrete. [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.9(2) - Formula (3.26)

Parameters

f_ck
[MPA] [fck] Characteristic compressive strength [MPa]

f_ck_c
[MPA] [fck,c] Increased characteristic compressive strength due to enclosed concrete [MPa]. See classes Form3Dot24IncreasedCharacteristicCompressiveStrength and/or Form3Dot25IncreasedCharacteristicCompressiveStrength

epsilon_c2
[float] [c2] Strain at maximum strength [-]

Returns

None

formula_3_27

Formula 3.27 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_27.**Form3Dot27Incr**

Bases: *Formula*

Class representing formula 3.27 for the calculation of the increased strain limit value due to enclosed concrete.

label = '3.27'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_ck: float*, *sigma_2: float*, *epsilon_cu2: float*) → None

[cu2,c] Increased strain limit value due to enclosed concrete. [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.9(2) - Formula (3.27)

Parameters

f_ck
[MPA] [fck] Characteristic compressive strength [MPa]

sigma_2
[MPA] [2] Effective compressive stress in transverse direction [MPa]

epsilon_cu2
[float] [cu2] Strain limit value [-]

Returns

None

formula_3_28

Formula 3.28 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_28.**Form3Dot28Rati**

Bases: *Formula*

Class representing formula 3.28 for the calculation of the ratio between loss of pre-stress and initial pre-stress of class 1.

label = '3.28'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*rho_1000: float*, *mu: float*, *t: float*) → None

[pr / pi] Ratio between loss of pre-stress and initial pre-stress for class 2 [-].

NEN-EN 1992-1-1+C2:2011 art.3.3.2(7) - Formula (3.28)

Parameters

rho_1000
[PERCENTAGE] [1000] Value of relaxation loss at 1000h after prestressing at an average temperature of 20 degrees Celsius [%]

mu
[float] [] Ratio between initial pre-stress and characteristic tensile strength [-] = pi / fpk Use your own implementation of this formula or use sub_formula_3_28_39_30 class SubForm3Dot282930Mu.

t
[HOURS] [t] Time after prestressing [hours]

Returns

None

formula_3_29

Formula 3.29 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_29.**Form3Dot29Rati**

Bases: *Formula*

Class representing formula 3.29 for the calculation of the ratio between loss of pre-stress and initial pre-stress of class 2.

label = '3.29'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*rho_1000: float*, *mu: float*, *t: float*) → None

[pr / pi] Ratio between loss of pre-stress and initial pre-stress for class 2. [-].

NEN-EN 1992-1-1+C2:2011 art.3.3.2(7) - Formula (3.29)

Parameters

rho_1000
[PERCENTAGE] [1000] Value of relaxation loss at 1000h after prestressing at an average temperature of 20 degrees Celsius [%]

mu
[float] [] Ratio between initial pre-stress and characteristic tensile strength [-] = pi / fpk Use your own implementation of this formula or use sub_formula_3_28_39_30 class SubForm3Dot282930Mu.

t
[HOURS] [t] Time after prestressing [hours]

Returns

None

formula_3_3

Formula 3.3 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_3.Form3Dot3AxialT`

Bases: *Formula*

Class representing formula 3.3 for the approximated axial tensile strength, fct, determined by tensile splitting strength.

label = '3.3'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_ct_sp: float*) → None

[fct] The approximated axial tensile strength when tensile strength is determined as coefficient which is dependent of the age of concrete [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.2(8) - Formula (3.3)

Parameters

f_ct_sp
[float] [fct,sp] Tensile strength determined by tensile splitting strength [MPa].

Returns

None

formula_3_30

Formula 3.30 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_30.Form3Dot30Rati
```

Bases: *Formula*

Class representing formula 3.30 for the calculation of the ratio between loss of pre-stress and initial pre-stress of class 3.

label = '3.30'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*rho_1000: float*, *mu: float*, *t: float*) → None

[pr / pi] Ratio between loss of pre-stress and initial pre-stress for class 3. [-].

NEN-EN 1992-1-1+C2:2011 art.3.3.2(7) - Formula (3.30)

Parameters

rho_1000
[PERCENTAGE] [1000] Value of relaxation loss at 1000h after prestressing at an average temperature of 20 degrees Celsius [%]

mu
[float] [] Ratio between initial pre-stress and characteristic tensile strength [-] = pi / fpk Use your own implementation of this formula or use sub_formula_3_28_39_30 class SubForm3Dot282930Mu.

t
[HOURS] [t] Time after prestressing [hours]

Returns

None

formula_3_4

Formula 3.4 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_4.**Form3DotDevelop**

Bases: *Formula*

Class representing formula 3.4 for an initial estimation of the tensile strength, fctm(t), after t days.

label = '3.4'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*beta_cc_t: float*, *alpha: float*, *f_ctm: float*) → None

[fctm(t)] The initial estimation of the tensile strength after t days [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.2(9) - Formula (3.4)

Parameters

beta_cc_t
[float] [cc(t)] Coefficient dependent of the age of concrete [-].

alpha
[float] [] Factor dependent of the age of concrete [-] alpha = 1 for t < 28 days alpha = 2/3 for t >= 28 days Use your own implementation of this value or use the SubForm3Dot4CoefficientAgeConcreteAlpha class.

f_ctm
[MPA] [fctm] Tensile strength from table 3.1 [MPa].

Returns

None

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_4.**SubForm3Dot4Coe**

Bases: *Formula*

Class representing sub-formula for formula 3.4 for the coefficient ‘’ which is dependent of the age of concrete.

label = '3.4'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*t: float*) → None

[] Factor dependent of the age of concrete [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.2(9) -

Parameters

t
[DAYS] [t] Age of concrete in days [days].

formula_3_5

Formula 3.5 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_5.Form3Dot5Approx`

Bases: `Formula`

Class representing formula 3.5 for the approximation of the elastic modulus, Ecm(t) at day t.

`label = '3.5'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*f_cm_t: float*, *f_cm: float*, *e_cm: float*) → None

[Ecm(t)] The approximated elastic modulus at day t [MPa].

NEN-EN 1992-1-1+C2:2011 art.3.1.3(3) - Formula (3.5)

Parameters

f_cm_t
[MPA] [fcm(t)] Compressive strength concrete at t days [MPa].

f_cm
[MPA] [fcm] Average concrete compressive strength on day 28 based on table 3.1 [MPa].

e_cm
[MPA] [Ecm] Average elastic modulus on day 28 [MPa].

Returns

None

formula_3_6

Formula 3.6 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_6.Form3Dot6CreepD`

Bases: *Formula*

Class representing formula 3.6 for the calculation of creep deformation of concrete.

label = '3.6'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*phi_inf_t0: float*, *sigma_c: float*, *e_c: float*) → None

cc(∞,t0) Creep deformation of concrete at the time t = ∞ for a constant concrete compressive stress c applied at time t0 [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(3) - Formula (3.6)

Parameters

phi_inf_t0
[float] [(∞, t0)] Creep coefficient if high accuracy is not required use figure 3.1 else use appendix B [-].

sigma_c
[MPA] [c] Concrete compressive stress [MPa].

e_c
[MPA] [Ec] tangent modulus = 1.05 * Ecm. According to art.3.1.4(2) [MPa].

Returns

None

formula_3_7

Formula 3.7 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_7.Form3Dot7NonLin`

Bases: *Formula*

Class representing formula 3.7 for the calculation of the non-linear creep coefficient.

label = '3.7'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*phi_inf_t0: float*, *k_sigma: float*) → None

[nl(∞,t0)] The non-linear creep coefficient [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(4) - Formula (3.7)

Parameters

phi_inf_t0
[float] [(∞, t0)] Creep coefficient if high accuracy is not required use figure 3.1 and/or use appendix B [-].

k_sigma
[float] [k] Stress-strength ratio (c / fck(t0)) [-].

Returns

None

formula_3_8

Formula 3.8 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_8.Form3Dot8TotalS`

Bases: `Formula`

Class representing formula 3.8 for the calculation of the total shrinkage.

label = '3.8'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*epsilon_cd: float*, *epsilon_ca: float*) → None

[cs] The total shrinkage [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(6) - Formula (3.8)

Parameters

epsilon_cd
[float] [cd] Drying shrinkage [-].

epsilon_ca
[float] [ca] Autogene shrinkage [-].

Returns

None

formula_3_9

Formula 3.9 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.formula_3_9.Form3Dot9DryingS
```

Bases: *Formula*

Class representing formula 3.9 for the calculation of the drying shrinkage.

```
label = '3.9'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

__init__(*beta_ds_tt_s: float*, *k_h: float*, *epsilon_cd_0: float*) → None

[cd(t)] Development of the drying shrinkage [-].

NEN-EN 1992-1-1+C2:2011 art.3.1.4(6) - Formula (3.9)

Parameters

beta_ds_tt_s
[float] [ds(t, ts)] Coefficient that depends on the age t (in days) of the concrete for the drying shrinkage [-].

k_h
[float] [kh] Coefficient depending on the fictional thickness h0 following table 3.3 [-]. h0 = 100 -> kh = 1.0 h0 = 200 -> kh = 0.85 h0 = 300 -> kh = 0.75 h0 >= 500 -> kh = 0.70

epsilon_cd_0
[float] [cd,0] Nominal unobstructed drying shrinkage, formula in appendix B or use table 3.2 [-].

Returns

None

sub_formula_3_28_29_30

Sub-formula 3.28, 3.29 and 3.30 from NEN-EN 1992-1-1+C2:2011: Chapter 3 - Materials.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_3_materials.sub_formula_3_28_29_30.**SubF**

Bases: *Formula*

Class representing sub-formula for 3.28, 3.29 and 3.30 for the calculation of .

label = '3.28 - 3.29 - 3.30'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*sigma_pi: float*, *f_pk: float*) → None

[] Ratio between initial pre-stress and characteristic tensile strength (pi / fpk) [-].

NEN-EN 1992-1-1+C2:2011 art.3.3.2(7) -

Parameters

sigma_pi
[MPA] [pi] Initial pre-stress [MPa]

f_pk
[MPA] [fpk] Characteristic tensile strength of pre-stress steel [MPa]

Returns

None

chapter_4_durability_and_cover

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 4 - Durability and cover to reinforcement.

blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_4_durability_and_cover.formula_4_1	Formula 4.1 from NEN-EN 1992-1-1+C2:2011: Chapter 4 - Durability and cover to reinforcement.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_4_durability_and_cover.formula_4_2	Formula 4.2 from NEN-EN 1992-1-1+C2:2011: Chapter 4 - Durability and cover to reinforcement.

formula_4_1

Formula 4.1 from NEN-EN 1992-1-1+C2:2011: Chapter 4 - Durability and cover to reinforcement.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_4_durability_and_cover.formula_4_1.**Form**

Bases: *Formula*

Class representing the formula 4.1 for the calculation of the nominal concrete cover c_{nom} $[mm]$.

label = '4.1'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*c_min: float*, *delta_c_dev: float*) → None

$[c_{nom}]$ Calculates the nominal concrete cover $[mm]$.

NEN-EN 1992-1-1+C2:2011 art.4.4.1.1 (2) - Formula (4.1)

Parameters

c_min: MM
$[c_{min}]$ Minimum concrete cover based on art. 4.4.1.2 $[mm]$.

delta_c_dev: MM
$[c_{dev}]$ Construction tolerance based on art. 4.4.1.3 $[mm]$.

latex() → *LatexFormula*

Returns LatexFormula object for formula 4.1.

Return type
LatexFormula

formula_4_2

Formula 4.2 from NEN-EN 1992-1-1+C2:2011: Chapter 4 - Durability and cover to reinforcement.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_4_durability_and_cover.formula_4_2.**Form**

Bases: *Formula*

Class representing the formula 4.2 for the calculation of the minimum concrete cover c_{min} $[mm]$.

label = '4.2'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*c_min_b: float*, *c_min_dur: float*, *delta_c_dur_gamma: float*, *delta_c_dur_st: float*, *delta_c_dur_add: float*) → None

[c_{min}] Calculates the minimum concrete cover [mm].

A minimum concrete cover of 10 mm is required, even if the calculated value is lower.

NEN-EN 1992-1-1+C2:2011 art.4.4.1.2 (2) - formula (4.2)

Parameters

c_min_b: MM
[$c_{min,b}$] The minimum concrete cover based on the adhesion requirements based on art. 4.4.1.2 (3) [mm].

c_min_dur: MM
[$c_{min,dur}$] The minimum concrete cover based on environmental conditions based on art. 4.4.1.2 (5) [mm].

delta_c_dur_gamma: MM
[$c_{dur,}$] An additional safety requirement based on art. 4.4.1.2 (6) [mm].

delta_c_dur_st: MM
[$c_{dur,st}$] A reduction of minimum concrete cover when using stainless steel based on art. 4.4.1.2 (7) [mm].

delta_c_dur_add: MM
[$c_{dur,add}$] A reduction of minimum concrete cover when using additional protection based on art. 4.4.1.2 (8) [mm].

latex() → *LatexFormula*

Returns LatexFormula object for formula 4.2.

Return type
LatexFormula

chapter_5_structural_analysis

Module containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_1	Formula 5.1 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_11n	Formula 5.11N from NEN-EN 1992-1-1 C2:2011: Chapter 5 Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_12n	Formula 5.12N from NEN-EN 1992-1-1 C2:2011: Chapter 5 Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_14	Formula 5.14 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_2	Formula 5.1 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_3a	Formula 5.3a from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_3b	Formula 5.3b from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_4	Formula 5.4 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_5	Formula 5.5 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_6	Formula 5.6 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7	Formula 5.7 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7a	Formula 5.7a from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7ab	Formula 5.7a and 5.7b from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7b	Formula 5.7b from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_8	Formula 5.8 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_9	Formula 5.9 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

formula_5_1

Formula 5.1 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_1.Form5I
```

Bases: *Formula*

Class representing formula 5.1 for the calculation of initial inclination imperfections, i.

label = '5.1'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*theta_0: float*, *alpha_h: float*, *alpha_m: float*) → None

[i] Initial inclination imperfections, i, is a ratio between height and inclination of the member [-].

NEN-EN 1992-1-1+C2:2011 art.5.2(5) - Formula (5.1)

Parameters

theta_0
[float] [0] Basic value [-]. Note: The value of 0 for use in a Country may be found in its National Annex. The recommended value is 1/200

alpha_h
[float] [h] Reduction factor for length or height [-]. Use your own implementation of this value or use the SubForm5Dot1ReductionFactorLengthOrHeight class.

alpha_m
[float] [m] Reduction factor for number of members [-]. Use your own implementation of this value or use the SubForm5Dot1ReductionFactorNumberOfMembers class.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_1.SubFo
```

Bases: *Formula*

Class representing sub-formula 5.1 for the calculation of the reduction factor for length or height, h.

label = '5.1'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*length: float*) → None

[h] Reduction factor for length or height [-].

The calculated value of h is between 2/3 and 1.0.

NEN-EN 1992-1-1+C2:2011 art.5.2(5) - Formula (5.1)

Parameters

length
[M] [length] Length or height, see art.5.2(6) [m].

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_1.**SubFo**

Bases: *Formula*

Class representing sub-formula 5.1 for the calculation of the reduction factor for number of members, m.

label = '5.1'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*members: int*) → None

[m] Reduction factor for number of members [-].

NEN-EN 1992-1-1+C2:2011 art.5.2(5) - Formula (5.1)

Parameters

members
[int] [m] Number of vertical members contributing to the total effect [-].

formula_5_11n

Formula 5.11N from NEN-EN 1992-1-1 C2:2011: Chapter 5 Structural Analysis.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_11n.**For**

Bases: *Formula*

Class representing formula 5.11N for the calculation of the shear slenderness correction factor [k].

label = '5.11N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*lambda_factor: float*) → None

[k] Shear slenderness correction factor.

NEN-EN 1992-1-1+C2:2011 art.5.6.3(4) - Formula (5.11N)

Parameters

lambda_factor
[DIMENSIONLESS] [] ratio of the distance between point of zero and maximum moment after redistribution and

effective depth, d $[-]$

Use your own implementation for this value or use `Form5Dot12nRatioDistancePointZeroAndMaxMoment`.

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.11N.

Return type
LatexFormula

formula_5_12n

Formula 5.12N from NEN-EN 1992-1-1 C2:2011: Chapter 5 Structural Analysis.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_12n.For`

Bases: *Formula*

Class representing formula 5.12N for the calculation of the lambda ratio.

Note: Ratio of the distance between point of zero and maximum moment after redistribution and effective depth, d. []

label = '5.12N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*m_sd: float*, *v_sd: float*, *d: float*) → None

[] ratio of the distance between point of zero and maximum moment after redistribution and effective depth, d $[-]$.

NEN-EN 1992-1-1+C2:2011 art.5.6.3(4) - Formula (5.12N)

Parameters

m_sd
[KNM] [M_{sd}] Design moment at the section [kNm].

v_sd
[KN] [V_{sd}] Design shear force at the section [kN].

d
[M] [d] Effective depth [m].

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.12N.

Return type

LatexFormula

formula_5_14

Formula 5.14 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_14.**Form5**

Bases: *Formula*

Class representing formula 5.14 for the calculation of the slenderness ratio, .

label = '5.14'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*l_0: float*, *i: float*) → None

[] Slenderness ratio $[-]$.

NEN-EN 1992-1-1+C2:2011 art.5.8.3.2(1) - Formula (5.14)

Parameters

l_0

[M] [l_0] Effective length [m].

i

[M] [i] Radius of gyration of the uncracked concrete section [m].

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.14.

Return type

LatexFormula

formula_5_2

Formula 5.1 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_2.**Form5I**

Bases: *Formula*

Class representing formula 5.2 for the calculation of eccentricity, ei.

label = '5.2'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*theta_i: float*, *l_0: float*) → None

[ei] Eccentricity, ei, for isolated members [m].

NEN-EN 1992-1-1+C2:2011 art.5.2(7) - Formula (5.2)

Parameters

theta_i
[DIMENSIONLESS] [i] Eccentricity, initial inclination imperfections [-]. Use your own implementation of this value or use the Form5Dot1Imperfections class.

l_0
[M] [l0] Effective length of the member, see 5.8.3.2 [m].

formula_5_3a

Formula 5.3a from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_3a.**Form**

Bases: `Formula`

Class representing formula 5.3a for the calculation of the transverse force for unbraced members, H_i.

See Figure 5.1 a1.

label = '5.3a'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*theta_i: float*, *n_axial_force: float*) → None

[H_i] Transverse force for unbraced members [kN].

NEN-EN 1992-1-1+C2:2011 art.5.2(7) - Formula (5.3a)

Parameters

theta_i
[DIMENSIONLESS] [$_i$] Eccentricity, initial inclination imperfections [-].

Use your own implementation of this value or use the `Form5Dot1Imperfections` class.

n_axial_force
[KN] [N] Axial force [kN].

Positive values for compression, tension is not allowed.

Notes

Eccentricity is suitable for statically determinate members, whereas transverse load can be used for both determinate and indeterminate members. The force H_i may be substituted by some other equivalent transverse action.

formula_5_3b

Formula 5.3b from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_3b.Form`

Bases: *Formula*

Class representing formula 5.3b for the calculation of the transverse force for braced members, H_i.

See Figure 5.1 a2.

`label = '5.3b'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*theta_i: float*, *n_axial_force: float*) → None

[H_i] Transverse force for braced members [kN].

NEN-EN 1992-1-1+C2:2011 art.5.2(7) - Formula (5.3b)

Parameters

theta_i

[DIMENSIONLESS] [$_i$] Eccentricity, initial inclination imperfections [-].

Use your own implementation of this value or use the `Form5Dot1Imperfections` class.

n_axial_force

[KN] [N] Axial force [kN].

Positive values for compression, tension is not allowed.

Notes

Eccentricity is suitable for statically determinate members, whereas transverse load can be used for both determinate and indeterminate members. The force H_i may be substituted by some other equivalent transverse action.

`latex()` → *LatexFormula*

Returns LatexFormula object for formula 5.3b.

Return type

LatexFormula

formula_5_4

Formula 5.4 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_4.**Form5**

Bases: *Formula*

Class representing formula 5.4 for the calculation of the effect of the inclination on bracing systems, H_i.

See Figure 5.1 b.

label = '5.4'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*theta_i: float*, *n_a: float*, *n_b: float*) → None

$[H_i]$ Effect of the inclination on bracing systems $[kN]$.

NEN-EN 1992-1-1+C2:2011 art.5.2(8) - Formula (5.4)

Parameters

theta_i
[DIMENSIONLESS] $[_i]$ Eccentricity, initial inclination imperfections [-].

n_a
[KN] $[N_a]$ Axial force in the member $[kN]$.

n_b
[KN] $[N_b]$ Axial force in the member $[kN]$.

Notes

where $N_a and : math :$ ‘N_b are longitudinal forces contributing to H_i. Positive values for compression, tension is not allowed.

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.4.

Return type
LatexFormula

formula_5_5

Formula 5.5 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_5.Form5`

Bases: *Formula*

Class representing formula 5.5 for the calculation of the effect of the inclination on floor diaphragm, H_i.

See Figure 5.1 c1.

`label = '5.5'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*theta_i: float*, *n_a: float*, *n_b: float*) → None

[H_i] Effect of the inclination on floor diaphragm [kN].

NEN-EN 1992-1-1+C2:2011 art.5.2(8) - Formula (5.5)

Parameters

theta_i
[DIMENSIONLESS] [$_i$] Eccentricity, initial inclination imperfections [-].

n_a
[KN] [N_a] Axial force in the member [kN].

n_b
[KN] [N_b] Axial force in the member [kN].

Notes

where $N_a and : math : `N_b$ are longitudinal forces contributing to H_i. Positive values for compression, tension is not allowed.

`latex()` → *LatexFormula*

Returns LatexFormula object for formula 5.5.

Return type
LatexFormula

formula_5_6

Formula 5.6 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_6.Form5I`

Bases: *Formula*

Class representing formula 5.6 for the calculation of the effect of the inclination on roof diaphragm, H_i. See Figure 5.1 c2.

label = '5.6'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*theta_i: float*, *n_a: float*) → None

[H_i] Effect of the inclination on roof diaphragm [kN].

NEN-EN 1992-1-1+C2:2011 art.5.2(8) - Formula (5.6)

Parameters

theta_i
[DIMENSIONLESS] [$_i$] Eccentricity, initial inclination imperfections [-].

n_a
[KN] [N_a] Axial force in the member [kN].

Notes

where $N_a is a longitudinal force contributing to : math : `H_i$. Positive values for compression, tension is not allowed.

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.6.

Return type
LatexFormula

formula_5_7

Formula 5.7 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7.Form5I`

Bases: *Formula*

Class representing formula 5.7 for the calculation of effective flange width [b_{eff}] for a T beam or L beam. See Figure 5.3.

```
label = '5.7'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

__init__(**b_eff_i: float*, *b_w: float*, *b: float*) → None

[b_{eff}] Effective flange width for a T beam or L beam [m].

NEN-EN 1992-1-1+C2:2011 art.5.3.2.1(3) - Formula (5.7)

Parameters

b_eff_i
: [M] [$b_{eff,i}$] Effective flange width of the i-th flange [m].

b_w
: [M] [b_w] Width of the web [m].

b
: [M] [b] Total width of the flange [m].

Notes

where [$b_{eff,i}$] is the effective flange width of the i-th flange

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.7.

Return type
: LatexFormula

formula_5_7a

Formula 5.7a from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7a.Form
```

Bases: `Form5Dot7abFlangeEffectiveFlangeWidth`

Class representing formula 5.7a for the calculation of effective flange width of the i-th flange [$b_{eff,i}$]. See Figure 5.3.

```
label = '5.7a'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

formula_5_7ab

Formula 5.7a and 5.7b from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7ab.For`

Bases: *Formula*

Class representing formula 5.7a and formula 5.7b for the calculation of effective flange width of the i-th flange [$b_{eff,i}$]. See Figure 5.3.

label = '5.7a, 5.7b'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*b_i: float*, *l_0: float*) → None

[$b_{eff,i}$] Effective flange width of the i-th flange of a beam [m].

NEN-EN 1992-1-1+C2:2011 art.5.3.2.1(3) - Formula (5.7a) and (5.7b)

Parameters

b_i
[M] [b_i] Effective flange width of the i-th flange [m].

l_0
[M] [l_0] distance between points of zero moment, which may be obtained from Figure 5.2 [m].

Notes

This formula is the combination of formula 5.7a and 5.7b. Formula 5.7a and 5.7b cannot be used independently.

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.7.

Return type
LatexFormula

formula_5_7b

Formula 5.7b from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_7b.Form`

Bases: *Form5Dot7abFlangeEffectiveFlangeWidth*

Class representing formula 5.7b for the calculation of effective flange width of the i-th flange [$b_{eff,i}$]. See Figure 5.3.

`label = '5.7b'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

formula_5_8

Formula 5.8 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_8.Form5`

Bases: *Formula*

Class representing formula 5.8 for calculating the effective span of beams and slabs, l_{eff}.

See Figure 5.4

`label = '5.8'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*l_n: float*, *a_1: float*, *a_2: float*) → None

[l_{eff}] the effective span of a member [m].

NEN-EN 1992-1-1+C2:2011 art.5.3.2.2(1) - Formula (5.8)

Parameters

l_n
[M] [l_n] clear distance between the faces of the supports [m].

a_1
[M]

[a_1] values for a_1 and a_2 at each end of the span, may be determined from the appropriate a_i values in Figure 5.4 where t is the width of the supporting element as shown. [m].

a_2
[M]

[a_2] values for a_1 and a_2 at each end of the span, may be determined from the appropriate a_i values in Figure 5.4 where t is the width of the supporting element as shown. [m].

`latex()` → *LatexFormula*

Returns LatexFormula object for formula 5.8.

Return type
LatexFormula

formula_5_9

Formula 5.9 from NEN-EN 1992-1-1+C2:2011: Chapter 5 - Structural Analysis.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_5_structural_analysis.formula_5_9.**Form5**

Bases: *Formula*

Class representing formula 5.9 for the calculation of the design support moment reduction, M_{Ed}. See Figure 5.4 b.

label = '5.9'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_ed_sup: float*, *t: float*) → None

[M_{Ed}] Design support moment reduction [kN].

Note: Regardless of the method of analysis used, where a beam or slab is continuous over a support which may be considered to provide no restraint to rotation (e.g. over walls), the design support moment, calculated on the basis of a span equal to the centre-to-centre distance between supports, may be reduced by an amount M_{Ed}.

NEN-EN 1992-1-1+C2:2011 art.5.3.2.2(4) - Formula (5.9)

Parameters

f_ed_sup
[KN] [$F_{Ed,sup}$] Design support reaction [kN].

t
[M] [t] breadth of the support (see Figure 5.4 b) [m].

Note: Where support bearings are used [t] should be taken as the bearing width.

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.9.

Return type
LatexFormula

chapter_6_ultimate_limit_state

Module containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 6 - Ultimate limit state.

blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_6_ultimate_limit_state.formula_6_1	Formula 6.1 from NEN-EN 1992-1-1+C2:2011: Chapter 6 - Ultimate limit state.

formula_6_1

Formula 6.1 from NEN-EN 1992-1-1+C2:2011: Chapter 6 - Ultimate limit state.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_6_ultimate_limit_state.formula_6_1.**Form**

Bases: *Formula*

Class representing formula 6.1 for the design shear strength, VRd.

label = '6.1'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*v_rd_s: float*, *v_ccd: float*, *v_td: float*) → None

[VRd] Design shear resistance of an element with shear reinforcement.

NEN-EN 1992-1-1+C2:2011 art.6.2.1(2) - Formula (6.1)

Parameters

v_rd_s
[KN] [VRd,s] Design shear resistance of an element with shear reinforcement [kN].

v_ccd
[KN] [Vccd] Design value of the shear force component in the compression area in case of a change in height [kN].

v_td
[KN] [Vtd] Design value of the shear force component of the tensile force in the reinforcement in case of a change in height [kN].

chapter_7_serviceability_limit_state

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 7 - Serviceability Limit States (SLS).

blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_7_serviceability_limit_state.formula_7_3	Formula 7.3 from NEN-EN 1992-1-1+C2:2011: Chapter 7 - Serviceability limit state (SLS).

formula_7_3

Formula 7.3 from NEN-EN 1992-1-1+C2:2011: Chapter 7 - Serviceability limit state (SLS).

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_7_serviceability_limit_state.formula_7_3`

Bases: *Formula*

Class representing the formula 7.3 for the coefficient kc for flanges of tubular cross-sections and T-sections.

label = '7.3'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_cr: float*, *a_ct: float*, *f_ct_eff: float*) → None

[kc] Calculates kc for flanges of tubular cross-sections and T-sections [-].

NEN-EN 1992-1-1:2011 art.7.3.2(2) - Formula (7.3)

Parameters

f_cr
[KN] [Fcr] Absolute value of the tensile force within the flange immediately before cracking due to the cracking moment calculated with fct,eff [kN].

a_ct
[MM2] [Act] Area of the concrete within the tension zone. The tension zone is that part of the cross-section that, according to the calculation, is under tension just before the first crack occurs [mm^2].

f_ct_eff
[MPA] [fc,eff] Average value of the tensile strength of the concrete at the time when the first cracks can be expected [MPa].

chapter_8_detailing_of_reinforcement_and_prestressing_tendons

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 8 - Detailing of reinforcement and prestressing tendons - General.

blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_1	Formula 8.1 from NEN-EN 1992-1-1+C2:2011: Chapter 8 Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_10	Formula 8.10 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_11	Formula 8.11 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_12	Formula 8.12 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_13	Formula 8.13 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_14	Formula 8.14 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_15	Formula 8.15 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_16	Formula 8.16 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_17	Formula 8.17 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_18	Formula 8.18 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_2	Formula 8.2 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_3	Formula 8.3 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_4	Formula 8.4 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre formula_8_6	Formula 8.6 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.
blueprints.codes.eurocode. nen_en_1992_1_1_c2_2011. chapter_8_detailing_of_reinforcement_and_pre	Formula 8.7 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

formula_8_1

Formula 8.1 from NEN-EN 1992-1-1+C2:2011: Chapter 8 Detailing of reinforcement and prestressing tendons.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing formula 8.1 for the calculation of the required minimum mandrel diameter if it needs to be checked to avoid concrete failure.

label = '8.1'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_bt: float*, *a_b: float*, *diameter: float*, *f_cd: float*) → None

[Øm,min] minimum mandrel diameter if it needs to be checked to avoid concrete failure [MM].

NEN-EN 1992-1-1+C2:2011 art.8.3(3) - Formula (8.1)

Parameters

f_bt: KN
[Fbt] Tensile force from ultimate loads in a bar or group of bars in contact at the start of a bend [kN].

a_b: MM
[ab] Half of the centre-to-centre distance between bars (or groups of bars) perpendicular to the plane of the bend for a given bar (or group of bars in contact). For a bar or group of bars adjacent to the face of the member, 'ab' should be taken as the cover plus Ø/2 [mm].

diameter: MM
[Ø] Diameter of reinforcing bar [mm].

f_cd: MPA
[fcd] Design value of concrete compressive stress [MPa]. Note: The value of fcd should not be taken greater than that for concrete class C55/67.

formula_8_10

Formula 8.10 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing formula 8.10 for the calculation of the design lap length l_0 $[mm]$.

label = '8.10'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*alpha_1: float*, *alpha_2: float*, *alpha_3: float*, *alpha_5: float*, *alpha_6: float*, *l_b_rqd: float*, *l_0_min: float*) → None

[l_0] Design lap length [mm].

NEN-EN 1992-1-1+C2:2011 art.8.7.3(1) - Formula (8.10)

Parameters

alpha_1

[DIMENSIONLESS] [$_1$] Coefficient for the effect of the form of the bars assuming adequate cover (see figure 8.1) [-].

$= 1.0$ for bars in compression.

$= 1.0$ for straight bars in tension.

$= 1.0$ if $c_d <= 3$ for bars other than straight in tension (see figure 8.1 (b), (c) and (d)).

$= 0.7$ if $c_d > 3$ for bars other than straight in tension (see figure 8.1 (b), (c) and (d)).

Note: see figure 8.3 for values of cd.

alpha_2

[DIMENSIONLESS] [$_2$] Coefficient for the effect of minimum concrete cover (see figure 8.3) [-].

$= 1.0$ for bars in compression.

$= 1 - 0.15(c_d -)/ <= 1$ with a minimum of 0.7 for straight bars in tension.

$= 1 - 0.15(c_d - 3)/ <= 1$ with a minimum of 0.7 for bars other than straight in tension (see figure 8.1 (b), (c) and (d)).

Note: see figure 8.3 for values of c_d.

alpha_3

[DIMENSIONLESS] [$_3$] Coefficient for the effect of confinement by transverse reinforcement [-].

$= 1.0$ for bars in compression.

$= 1 - K <= 1$ with a minimum of 0.7 for bars in tension.

Where: $= (A_{st} - A_{st,min})/A_s$.

Where: $A_{st,min} = A_s(_{sd}/f_{yd})$

With A_s = area of one lapped bar [mm^2].

Note: see figure 8.4 for values of K, A_s and A_{st}.

alpha_5

[DIMENSIONLESS] [$_5$] Coefficient for the effect of the pressure transverse to the plane of splitting along the design anchorage length l_{bd} (see 8.6) [-].

$= 1 - 0.04p <= 1$ with a minimum of 0.7 for all types of anchorage in compression.

Where: p = transverse pressure at ultimate limit state along l_{bd} [MPa].

alpha_6

[DIMENSIONLESS] [$_6$] Coefficient for the effect of reinforcement ratio [-].

$= (_1/25)^{0.5} <= 1.5$ with a minimum of 1.0.

Where: $_1$ = reinforcement percentage lapped within $0,65l_0$ from the centre of the lap length considered (see figure 8.8) [-].

Use your own implementation of this formula or use the *SubForm8Dot10Alpha6* class.

l_b_rqd
[MM] [$l_{b,rqd}$] Basic required anchorage length, for anchoring the force A_{ssd} in a straight bar assuming constant bond stress (formula 8.3) [mm].

Use your own implementation for this value or use the `Form8Dot3RequiredAnchorageLength` class.

l_0_min
[MM] [$l_{0,min}$] Minimum design lap length [mm].

$= max(0.3_6 l_{b,rqd}, 15, 200)$ (formula 8.11).

Use your own implementation of this formula or use `Form8Dot11MinimumDesignLapLength` class.

latex() → *LatexFormula*

Returns a LatexFormula representation of the formula.

Return type
LatexFormula

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing the formula for the calculation of the coefficient $_6$.

label = '8.8'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*rho_1: float*) → None

[$_6$] Coefficient for the effect of reinforcement ratio [-].

NEN-EN 1992-1-1+C2:2011 art.8.7.3(1) - Formula (8.8)

Parameters

rho_1
[DIMENSIONLESS] [$_1$] Reinforcement percentage lapped within $0, 65l_0$ from the centre of the lap length considered (see figure 8.8) [-].

latex() → *LatexFormula*

Returns a LatexFormula representation of the formula.

Return type
LatexFormula

formula_8_11

Formula 8.11 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing formula 8.11 for the calculation of the minimum design lap length $l_{0,min}$ $[mm]$.

label = '8.11'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*alpha_6: float*, *l_b_rqd: float*, *diameter: float*) → None

[$l_{0,min}$] Design minimum lap length $[mm]$.

NEN-EN 1992-1-1+C2:2011 art.8.7.3(1) - Formula (8.11)

Parameters

alpha_6

[DIMENSIONLESS] [$_6$] Coefficient for the effect of reinforcement ratio [-].

$= (_l/25)^{0.5} <= 1.5$ with a minimum of 1.0.

Where: $_l$ = reinforcement percentage lapped within $0.65l_0$ from the centre of the lap length considered (see figure 8.8) [-].

Use your own implementation for this value or use the `SubForm8Dot10Alpha6` class.

l_b_rqd: MM

[$l_{b,rqd}$] Basic required anchorage length, for anchoring the force A_{ssd} in a straight bar assuming constant bond stress (formula 8.3) $[mm]$.

Use your own implementation for this value or use the `Form8Dot3RequiredAnchorageLength` class.

diameter

[MM] [] Diameter of the bar $[mm]$.

latex() → *LatexFormula*

Returns a representation of the formula in LaTeX format.

Return type

LatexFormula

formula_8_12

Formula 8.12 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre

Bases: *Formula*

Class representing formula 8.12 for the calculation of the minimum additional shear reinforcement in the anchorage zones where transverse compression is not present for straight anchorage lengths, in the direction parallel to the tension face.

label = '8.12'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*a_s: float*, *n_1: float*) → None

[A_{sh}] Minimum additional shear reinforcement in the anchorage zones where transverse compression is not present for straight anchorage lengths, in the direction parallel to the tension face [mm].

NEN-EN 1992-1-1+C2:2011 art.8.8(6) - Formula (8.12)

Parameters

a_s: MM2
[A_s] Cross sectional area of reinforcement [mm].

n_1: DIMENSIONLESS
[n_1] Number of layers with bars anchored at the same point in the member [-].

formula_8_13

Formula 8.13 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre

Bases: *Formula*

Class representing formula 8.13 for the calculation of the minimum additional shear reinforcement in the anchorage zones where transverse compression is not present for straight anchorage lengths, in the direction perpendicular to the tension face.

label = '8.13'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*a_s: float*, *n_2: float*) → None

[A_{sh}] Minimum additional shear reinforcement in the anchorage zones where transverse compression is not present for straight anchorage lengths, in the direction perpendicular to the tension face [mm].

NEN-EN 1992-1-1+C2:2011 art.8.8(6) - Formula (8.12)

Parameters

a_s: MM2
$[A_s]$ Cross sectional area of reinforcement $[mm]$.

n_2: DIMENSIONLESS
$[n_2]$ Number of bars anchored in each layer [-].

formula_8_14

Formula 8.14 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing formula 8.14 for the calculation of the equivalent diameter of bundled bars, $_n$.

label = '8.14'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*diameter: float*, *n_b: float*) → None

$[_n]$ Equivalent diameter of bundled bars $[mm]$.

NEN-EN 1992-1-1+C2:2011 art.8.9.1(2) - Formula (8.14)

Parameters

diameter
[MM] [] Diameter of the bars $[mm]$

n_b
[DIMENSIONLESS] $[n_b]$ Number of bars in the bundle [-].

4 for vertical bars in compression and for bars in a lapped joint.

3 for all other cases.

formula_8_15

Formula 8.15 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing formula 8.15 for the calculation of the constant bond stress at which prestress is assumed to be transferred to the concrete, at the release of tendons.

label = '8.15'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*eta_p1: float*, *eta_1: float*, *f_ctd_t: float*) → None

[f_{bpt}] Constant bond stress at which prestress is assumed to be transferred to the concrete [MPa].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(1) - Formula (8.15)

Parameters

eta_p1

[DIMENSIONLESS] [$_{p1}$] Coefficient that takes into account the type of tendon and the bond situation at release [-].

= 2.7 for indented wires.

= 3.2 for 3 and 7-wire strands

Use your own implementation for this value or use `SubForm8Dot15EtaP1` class.

eta_1

[DIMENSIONLESS] [$_1$] Coefficient related to the quality of the bond condition and the position of the bar during concreting (see Figure 8.2) [-].

= 1 when 'good' conditions are obtained;

= 0.7 other cases and for bars in structural elements built with slip-forms, unless it can be shown that 'good' bond conditions exist;

Use your own implementation of this formula or use the `SubForm8Dot2CoefficientQualityOfBond` class.

f_ctd_t

[MPA] [$f_{ctd}(t)$] Design tensile value of strength at time of release [mm].

= $_{ct}0.7 f_{ctm}(t)/_c$ (see 3.1.2(9) and 3.1.6(2)P)

Use your own implementation for this value or use `SubForm8Dot15TensileStrengthAtRelease` class.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre

Bases: `Formula`

Class representing sub-formula 8.15 for the calculation of the coefficient that takes into account the type of tendon and the bond situation at release.

label = '8.15'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*type_of_wire: str*) → None

[$_{p1}$] Coefficient that takes into account the type of tendon and the bond situation at release [-].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(1) - Formula (8.15)

Parameters

type_of_wire

[str] Type of wire.

= 'indented' for indented wires;

= '3_7_wire_strands' for 3 and 7-wire strands;

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing sub-formula 8.15 for the calculation of the design tensile value of strength at time of release (see 3.1.2(8) and 3.1.6(2)P).

label = '8.15'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*alpha_ct: float*, *f_ctm_t: float*, *gamma_c: float*) → None

[$f_{ctd}(t)$] Design tensile value of strength at time of release [MPa].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(1) - Formula (8.15)

Parameters

alpha_ct

[DIMENSIONLESS] [$_{ct}$] coefficient taking account of long term effects on the tensile strength and of unfavourable effects, resulting from the way the load is applied. [-].

Value may be found in national annex. Recommended value: 1.0

f_ctm_t

[MPA] [$f_{ctm}(t)$] Mean value of tensile strength at time of release (see formula 3.4) [MPa].

Use your own implementation for this value or use `Form3Dot4DevelopmentTensileStrength` class.

gamma_c

[DIMENSIONLESS] [$_{c}$] Partial safety factor for concrete [-].

formula_8_16

Formula 8.16 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre

Bases: *Formula*

Class representing formula 8.16 for the calculation of the basic transmission length l_{pt}.

label = '8.16'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*alpha_1: float*, *alpha_2: float*, *diameter: float*, *sigma_pm0: float*, *f_bpt: float*) → None

[l_{pt}] Basic value of the transmission length [mm].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(2) - Formula (8.16)

Parameters

alpha_1
[DIMENSIONLESS] [$_1$] Coefficient taking account of the type of release [-].

= 1.0 for gradual release;

= 1.25 for sudden release.

Use your own implementation for this value or use *SubForm8Dot16Alpha1* class.

alpha_2
[DIMENSIONLESS] [$_2$] Coefficient taking account of the type of prestressing steel [-].

= 0.25 for tendons with circular cross-section;

= 0.19 for 3 and 7-wire strands.

Use your own implementation for this value or use *SubForm8Dot16Alpha2* class.

diameter
[MM] [] Nominal diameter of the tendon [mm].

sigma_pm0
[MPA] [$_{pm0}$] Tendon stress at time of release [MPa].

f_bpt
[MPA] [f_{bpt}] Constant bond stress at which prestress is assumed to be transferred to the concrete [MPa]

Use your own implementation for this value or use `Form8Dot15PrestressTransferStress` class.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre

Bases: *Formula*

Class representing sub-formula 8.16 for the calculation of the coefficient $_1$.

```
label = '8.16'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

`__init__`(*release_type: str*) → None

[$_1$] Coefficient taking account of the type of release [-].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(2) - Formula (8.16)

Parameters

release_type
[str] Type of release, either "gradual" or "sudden".

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre
```

Bases: *Formula*

Class representing sub-formula 8.16 for the calculation of the coefficient $_2$.

```
label = '8.16'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

`__init__`(*type_of_wire: str*) → None

[$_2$] Coefficient that takes into account the type of wires in the cross-section [-].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(2) - Formula (8.16)

Parameters

type_of_wire
[str] Type of wire.

= 'circular' for circular cross-sections;

= '3_7_wire_strands' for 3 and 7-wire strands;

formula_8_17

Formula 8.17 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre
```

Bases: *Formula*

Class representing formula 8.17 for the calculation of design value 1 of the transmission length l_{pt1}. The less favourable of l_{pt1} or l_{pt2} has to be chosen depending on the design situation.

label = '8.17'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*l_pt: float*) → None

[l_{pt1}] design value 1 of the transmission length [mm].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(3) - Formula (8.17)

Parameters

l_pt
[MM] [l_{pt}] Basic value of the transmission length [mm]. Use your own implementation for this value or use `Form8Dot16BasicTransmissionLength` class.

formula_8_18

Formula 8.18 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: `Formula`

Class representing formula 8.18 for the calculation of design value 2 of the transmission length l_{pt2}. The less favourable of l_{pt1} or l_{pt2} has to be chosen depending on the design situation.

label = '8.18'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*l_pt: float*) → None

[l_{pt2}] design value 2 of the transmission length [mm].

NEN-EN 1992-1-1+C2:2011 art.8.10.2.2(3) - Formula (8.18)

Parameters

l_pt
[MM] [l_{pt}] Basic value of the transmission length [mm]. Use your own implementation for this value or use `Form8Dot16BasicTransmissionLength` class.

formula_8_2

Formula 8.2 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestr`

Bases: *Formula*

Class representing formula 8.2 for the calculation of the design value of the ultimate bond stress for ribbed bars.

label = '8.2'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*eta_1: float*, *eta_2: float*, *f_ctd: float*) → None

[f_{bd}] The design value of the ultimate bond stress for ribbed bars [-].

NEN-EN 1992-1-1+C2:2011 art.8.4.2(2) - Formula (8.2)

Parameters

eta_1

[DIMENSIONLESS] [$_1$] coefficient related to the quality of the bond condition and the position of the bar during concreting (see Figure 8.2) [-]. $= 1$ when 'good' conditions are obtained; $=$ 1 other cases and for bars in structural elements built with slip-forms, unless it can be shown that 'good' bond conditions exist; Use your own implementation of this formula or use the SubForm8Dot2CoefficientQualityOfBond class.

eta_2

[DIMENSIONLESS] [$_2$] A factor related to the bar diameter [-]. $= 1$ for bars with a diameter 32mm; $= (132 -)/100$ for bars with a diameter > 32mm. Use your own implementation of this value or use the SubForm8Dot2CoefficientBarDiameter class.

f_ctd

[MPA] [f_{ctd}] Design tensile strength of concrete according to art.3.1.6(2) [MPa]. Due to the increasing brittleness of higher strength concrete, $f_{ctk,0,05}$ should be limited here to the value for C60/75, unless it can be verified that the average bond strength increases above this limit.

latex() → *LatexFormula*

Returns a representation of the formula in LaTeX format.

Return type

LatexFormula

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestr`

Bases: *Formula*

Class representing sub-formula for formula 8.2, which calculates the coefficient '1' which is dependent on the quality of the bond.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '8.2'

__init__(*bond_quality: str*) → None

[1] Coefficient that depends on the type of cement [-].

NEN-EN 1992-1-1+C2:2011 art.8.4.2(2) - 1

Parameters

bond_quality
[str]

Quality of the bond.
= 'good' for a good bond condition.; = 'other' for other cases and for bars in structural elements built with slip-forms, unless it can be shown that 'good' bond conditions exist.;

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestr

Bases: *Formula*

Class representing sub-formula for formula 8.2, which calculates the coefficient '2' which is dependent on the bar diameter.

source_document = 'NEN-EN 1992-1-1+C2:2011'

label = '8.2'

__init__(*diameter: float*) → None

[$_2$] Coefficient that depends on the bar diameter [-].

NEN-EN 1992-1-1+C2:2011 art.8.4.2(2) - $_2$

Parameters

diameter
[MM] [] Diameter of the bar [mm].

latex() → *LatexFormula*

Returns a LatexFormula object for this formula.

Return type
LatexFormula

formula_8_3

Formula 8.3 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre
```

Bases: *Formula*

Class representing formula 8.3 for the calculation of the basic required anchorage length, assuming constant bond stress f_{bd}.

label = '8.3'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*diameter: float*, *sigma_sd: float*, *f_bd: float*) → None

[$l_{b,rqd}$] Basic required anchorage length, for anchoring the force A_s $cdot_{sd}$ in a straight bar assuming constant bond stress f_{bd}. [mm].

NEN-EN 1992-1-1+C2:2011 art.8.4.3(2) - Formula (8.3)

Parameters

diameter: MM
[] Diameter of the bar [mm].

sigma_sd: MPA
[$_{sd}$] design stress of the bar at the position from where the anchorage is measured from [MPa].

f_bd: MPA
[f_{bd}] Design value ultimate bond stress [MPa]. Use your own implementation for this value or use the Form8Dot2UltimateBondStress class.

latex() → *LatexFormula*

Returns a LatexFormula object for this formula.

Return type
LatexFormula

formula_8_4

Formula 8.4 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre
```

Bases: *Formula*

Class representing formula 8.4 for the calculation of the design anchorage length l_{bd} [mm].

label = '8.4'

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*alpha_1: float*, *alpha_2: float*, *alpha_3: float*, *alpha_4: float*, *alpha_5: float*, *l_b_rqd: float*, *l_b_min: float*) → None

[l_{bd}] Design anchorage length [mm].

NEN-EN 1992-1-1+C2:2011 art.8.4.4(1) - Formula (8.4)

Parameters

alpha_1

[DIMENSIONLESS] [$_1$] Coefficient for the effect of the form of the bars assuming adequate cover (see figure 8.1) [-].

$= 1.0$ for bars in compression.

$= 1.0$ for straight bars in tension.

$= 1.0 if c_d <= 3$ for bars other than straight in tension (see figure 8.1 (b), (c) and (d)).

$= 0.7 if c_d > 3$ for bars other than straight in tension (see figure 8.1 (b), (c) and (d)).

Note: see figure 8.3 for values of c_d.

alpha_2

[DIMENSIONLESS] [$_2$] Coefficient for the effect of minimum concrete cover (see figure 8.3) [-].

$= 1.0$ for bars in compression.

$= 1 - 0.15(c_d -)/ <= 1$ with a minimum of 0.7 for straight bars in tension.

$= 1 - 0.15(c_d - 3)/ <= 1$ with a minimum of 0.7 for bars other than straight in tension (see figure 8.1 (b), (c) and (d)).

Note: see figure 8.3 for values of c_d.

alpha_3

[DIMENSIONLESS] [$_3$] Coefficient for the effect of confinement by transverse reinforcement [-].

$= 1.0$ for bars in compression.

$= 1 - K <= 1$ with a minimum of 0.7 for bars in tension.

Where: $= (A_{st} - A_{st,min})/A_s$.

Where: $A_{st,min}$ = cross-sectional area of the minimum transverse reinforcement $= 0,25A_s$ for beams and 0 for slabs.

Note: see figure 8.4 for values of $K, A_s and A_{st}$.

alpha_4

[DIMENSIONLESS] [$_4$] Coefficient for the influence of one or more welded transverse bars ($_t > 0,6$) along the design anchorage length l_{bd} (see 8.6) [-].

$= 0.7$ for all types, position and size as specified in figure 8.6 (e) in both tension and compression.

alpha_5

[DIMENSIONLESS] [$_5$] Coefficient for the effect of the pressure transverse to the plane of splitting along the design anchorage length l_{bd} (see 8.6) [-].

$= 1 - 0.04p <= 1$ with a minimum of 0.7 for all types of anchorage in compression.

Where: p = transverse pressure at ultimate limit state along l_{bd} [MPa].

l_b_rqd: MM

[$l_{b,rqd}$] Basic required anchorage length, for anchoring the force Assd in a straight bar assuming constant bond stress (formula 8.3) [mm].

Use your own implementation for this value or use the `Form8Dot3RequiredAnchorageLength` class.

l_b_min

[MM] [$l_{b,min}$] Minimum anchorage length if no other limitation is applied [mm].

$= max(0.3 l_{b,rqd}, 10, 100)$ for tension anchorage (formula 8.6). $= max(0.6 l_{b,rqd}, 10, 100)$ for compression anchorage (formula 8.7).

Use your own implementation of this formula or use the `Form8Dot6MinimumTensionAnchorage` class for tension or `Form8Dot7MinimumCompressionAnchorage` for compression.

Notes

NEN-EN 1992-1-1+C2:2011 art.8.4.4(1) - Formula (8.5) prescribes that $(_{235}) >= 0.7$.

latex() → *LatexFormula*

Returns a LatexFormula representation of the formula.

Return type

LatexFormula

formula_8_6

Formula 8.6 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestr`

Bases: *Formula*

Class representing formula 8.6 for the calculation of the minimum anchorage length if no other limitation is applied for anchorage in tension.

label = '8.6'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*l_b_rqd: float*, *diameter: float*) → None

[lb,min] Minimum anchorage length if no other limitation is applied for anchorage in tension. [mm].

NEN-EN 1992-1-1+C2:2011 art.8.4.4(1) - Formula (8.6)

Parameters

l_b_rqd: MM
[lb,rqd] Basic required anchorage length, for anchoring the force As*sd in a straight bar assuming constant bond stress (formula 8.3) [mm]. Use your own implementation for this value or use the Form8Dot3RequiredAnchorageLength class.

diameter: MM
[Ø] Diameter of the bar [mm].

latex() → *LatexFormula*

Returns a LatexFormula object for this formula.

Return type
LatexFormula

formula_8_7

Formula 8.7 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre`

Bases: *Formula*

Class representing formula 8.7 for the calculation of the minimum anchorage length if no other limitation is applied for anchorage in compression.

`label = '8.7'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

__init__(*l_b_rqd: float*, *diameter: float*) → None

[lb,min] Minimum anchorage length if no other limitation is applied for anchorage in compression. [mm].

NEN-EN 1992-1-1+C2:2011 art.8.4.4(1) - Formula (8.7)

Parameters

l_b_rqd: MM
[lb,rqd] Basic required anchorage length, for anchoring the force As*sd in a straight bar assuming constant bond stress (formula 8.3) [mm]. Use your own implementation for this value or use the Form8Dot3RequiredAnchorageLength class.

diameter: MM
[Ø] Diameter of the bar [mm].

latex() → *LatexFormula*

Returns a LatexFormula object for this formula.

Return type

LatexFormula

formula_8_8n

Formula 8.8N from NEN-EN 1992-1-1+C2:2011: Chapter 8 - Detailing of reinforcement and prestressing tendons.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre

Bases: `Formula`

Class representing the formula 8.8N for the calculation of the anchorage capacity of welded transverse bar, welded on the inside of the main bar.

label = '8.8N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*l_td: float*, *diameter_t: float*, *sigma_td: float*, *f_wd: float*) → None

[F_{btd}] Anchorage capacity of welded transverse bar, welded on the inside of the main bar [kN].

Note: Value may be found in National Annex.

NEN-EN 1992-1-1+C2:2011 art.8.6(2) - formula (8.8N)

Parameters

l_td: MM

[l_{td}] Design length of transverse bar [mm].

$= 1.16_t(f_{yd}/_{td})^{0.5}l_t$

Use your own implementation of this formula or use the SubForm8Dot8nDesignLengthOfTransverseBar class.

diameter_t: MM

[$_t$] Diameter of transverse bar [mm].

sigma_td: MPA

[$_{td}$] Concrete stress [MPa].

$= (f_{ctd} + _{cm})/y3f_{cd}$

Use your own implementation of this formula or use the SubForm8Dot8nConcreteStress class.

f_wd: KN

[F_{wd}] Design shear strength of weld (specified as a factor times $A_s f_{yd}$; say $0.5A_s f_{yd}$ where A_s is the cross-section of the anchored bar and fyd is its design yield strength) [kN].

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre
```

Bases: *Formula*

Class representing sub-formula for formula 8.8N, which calculates the design length of the transverse bar.

label = '8.8N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*diameter_t: float*, *f_yd: float*, *sigma_td: float*, *l_t: float*) → None

$[l_{td}]$ Design length of transverse bar $[mm]$.

NEN-EN 1992-1-1+C2:2011 art.8.6(2) - l_{td}

Parameters

diameter_t: MM
$[_t]$ Diameter of transverse bar $[mm]$.

f_yd: MPA
$[f_{yd}]$ Design yield strength of bar $[MPa]$.

sigma_td: MPA
$[_{td}]$ Concrete stress $[MPa]$.

$= (f_{ctd} + _{cm}) / y3f_{cd}$

Use your own implementation of this formula or use the SubForm8Dot8nConcreteStress class.

l_t: MM
$[l_t]$ Length of transverse bar, but not more than the spacing of bars to be anchored $[mm]$.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestre
```

Bases: *Formula*

Class representing sub-formula for formula 8.8N, which calculates the concrete stress.

label = '8.8N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_ctd: float*, *sigma_cm: float*, *y_function: float*, *f_cd: float*) → None

$[_{td}]$ Concrete stress $[MPa]$.

NEN-EN 1992-1-1+C2:2011 art.8.6(2) - td

Parameters

f_ctd: MPA
: [f_{ctd}] Design tensile strength of concrete [MPa].

sigma_cm: MPA
: [$_{cm}$] Compression in the concrete perpendicular to both bars (mean value) [MPa].

y_function: DIMENSIONLESS
: [y] A function [-]

  $= 0.015 + 0.14 exp(-0.18x)$

  Use your own implementation of this formula or use the SubForm8Dot8nFunctionY class.

f_cd: MPA
: [f_{cd}] Design value compressive strength of concrete [MPa].

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestr`

Bases: *Formula*

Class representing sub-formula for formula 8.8N, which calculates the function y.

label = '8.8N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*x_function: float*) → None
: [y] A function [-].

  NEN-EN 1992-1-1+C2:2011 art.8.6(2) - y

Parameters

x_function: DIMENSIONLESS
: [x] A function accounting for the geometry [-]

  $= 2(c/_t) + 1$

  Use your own implementation of this formula or use the SubForm8Dot8nFunctionX class.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestr`

Bases: *Formula*

Class representing sub-formula for formula 8.8N, which calculates the function x.

label = '8.8N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*cover: float*, *diameter_t: float*) → None

[x] A function accounting for the geometry [-].

NEN-EN 1992-1-1+C2:2011 art.8.6(2) - x

Parameters

cover: MM
[c] Concrete cover perpendicular to both bars [mm].

diameter_t: MM
[$_t$] Diameter of transverse bar [mm].

formula_8_9

Formula 8.9 from NEN-EN 1992-1-1+C2:2011: Chapter 8: Detailing of reinforcement and prestressing tendons.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_8_detailing_of_reinforcement_and_prestr`

Bases: `Formula`

Class representing the formula 8.9 for the calculation of the anchorage capacity of a welded cross bar for nominal bar diameters smaller than 12 mm.

`label = '8.9'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

__init__(*f_wd: float*, *diameter_t: float*, *diameter_l: float*, *a_s: float*, *f_cd: float*) → None

[F_{btd}] Anchorage capacity of a welded cross bar for nominal bar diameters smaller than 12 mm [kN].

NEN-EN 1992-1-1+C2:2011 art.8.6(5) - formula 8.9

Parameters

f_wd
[KN] [F_{wd}] Design shear strength of weld (specified as a factor times $A_s f_{yd}$; say $0.5 A_s f_{yd}$ where A_s is the cross-section of the anchored bar and f_{yd} is its design yield strength) [kN].

diameter_t
[MM] [$_t$] Diameter of the transverse bar [mm].

Note: $_t =< 12mm$.

diameter_l
[MM] [$_l$] Diameter of the bar to be anchored [mm].

Note: $_l =< 12mm$.

a_s
[MM2] [A_s] Cross-section of the anchored bar [mm^2].

f_cd
[MPA] [f_{cd}] Design compressive strength of concrete [MPa].

chapter_9_detailling_and_specific_rules

Package containing all formulas from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_10	Formula 9.10 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_12n	Formula 9.12N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_13	Formula 9.13 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_14	Formula 9.14 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing and specific rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_16	Formula 9.16 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_1n	Formula 9.1N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_2	Formula 9.2 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_3	Formula 9.3 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_4	Formula 9.4 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_5n	Formula 9.5N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_6n	Formula 9.6N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_7n	Formula 9.7N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_8n	Formula 9.8N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.
blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_9_9	Formula 9.9 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.

formula_9_10

Formula 9.10 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_`

Bases: *Formula*

Class representing the formula 9.10 for the calculation of the maximum longitudinal spacing of bent up bars for slabs.

label = '9.10'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*d: float*) → None

[smax] Maximum longitudinal spacing of bent up bars for slabs [mm].

NEN-EN 1992-1-1+C2:2011 art.9.3.2(4) - Formula (9.10)

Parameters

d: MM
[d] Effective height of the cross-section [mm].

formula_9_12n

Formula 9.12N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_`

Bases: *Formula*

Class representing the formula 9.12N for the calculation of the minimum longitudinal reinforcement for columns.

label = '9.12N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*n_ed: float*, *f_yd: float*, *a_c: float*) → None

[As,min] Minimum longitudinal reinforcement for columns [mm^2].

NEN-EN 1992-1-1+C2:2011 art.9.5.2(2) - Formula (9.12N)

Parameters

n_ed: KN
[Ned] Design value of axial force [kN].

f_yd: MPA
[fyd] Design yield strength reinforcement steel [MPa].

a_c: MM2
[Ac] Concrete cross-sectional area [mm^2].

formula_9_13

Formula 9.13 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.

```
class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_
```

Bases: *Formula*

Class representing the formula 9.13 for the calculation of the tensile force to be anchored for.

```
label = '9.13'
```

```
source_document = 'NEN-EN 1992-1-1+C2:2011'
```

__init__(*r: float*, *z_e: float*, *z_i: float*) → None

[Fs] Tensile force to be anchored [kN].

NEN-EN 1992-1-1+C2:2011 art.9.8.2.2(2) - Formula (9.13)

Parameters

r: MM
[R] The resultant of ground pressure within x from figure 9.13 [mm].

z_e: MM
[ze] The external lever arm, see figure 9.13, i.e. distance between the reinforcement and the horizontal force Fc [mm].

z_i: MM
[zi] Internal lever arm, see figure 9.13, i.e. distance between R and the vertical force NEd [mm].

formula_9_14

Formula 9.14 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing and specific rules.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_

Bases: *Formula*

Class representing the formula 9.14 for the calculation of the splitting force on a column footing on rock.

label = '9.14'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*c: float*, *h: float*, *n_ed: float*) → None

[Fs] Splitting force on a column footing on rock [kN].

NEN-EN 1992-1-1+C2:2011 art.9.8.4(2) - Formula (9.14)

Parameters

c: MM
[c] Width over which NEd is applied [mm].

h: MM
[h] Lesser of b and H from figure 9.14 [mm].

n_ed: KN
[NEd] Design value of the applied axial force [kN].

formula_9_16

Formula 9.16 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_

Bases: *Formula*

Class representing the formula 9.16 for calculating the minimum force on an internal beam line for floors without screeds.

label = '9.16'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*q_3: float*, *l_1: float*, *l_2: float*, *q_4: float*) → None

[Ftie] Minimum force on an internal beam line [kN].

NEN-EN 1992-1-1+C2:2011 art.9.10.2.3(4) - Formula (9.16)

Parameters

q_3: KN_M
[q3] May be found in national annex, recommended value is 20 [kN/m].

l_1: M
[l1] span length of floor slabs on either side of the beam, see figure 9.15 [m].

l_2: M
[l2] span length of floor slabs on either side of the beam, see figure 9.15 [m].

q_4: KN
[Q4] May be found in national annex, recommended value is 70 [kN].

formula_9_1n

Formula 9.1N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_`

Bases: *Formula*

Class representing the formula 9.1N for the calculation of minimum tensile reinforcement area in longitudinal direction for beams.

label = '9.1N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*f_ctm: float*, *f_yk: float*, *b_t: float*, *d: float*) → None

[As,min] Calculates the minimum required tensile reinforcement area in longitudinal direction for beams [mm^2].

NEN-EN 1992-1-1+C2:2011 art.9.2.1.1(1) - Formula (9.1N)

Notes

As,min is no less than 0,0013 * bt * d

Parameters

f_ctm: MPA
[fctm] Mean axial tensile stress concrete [MPa]. Should be determined with respect to the relevant strength class according to Table 3.1

f_yk: MPA
[fyk] Characteristic yield strength reinforcement steel [MPa].

b_t: MM
[bt] Mean width of the concrete tension zone, for T-beams with a flange under compression only the width of the web is considered for calculating bt [mm].

d: MM
[d] Effective height of the cross-section [mm].

`latex()` → *LatexFormula*

Returns LatexFormula object for formula 9.1N.

Return type
LatexFormula

formula_9_2

Formula 9.2 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

class `blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_`

Bases: *Formula*

Class representing the formula 9.2 for the calculation of the shift in the moment diagram for elements with shear reinforcement.

`label = '9.2'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

`__init__`(*z: float*, *theta: float*, *alpha: float*) → None

[al] Shift in the moment diagram of an element with shear reinforcement [mm].

NEN-EN 1992-1-1+C2:2011 art.9.2.1.3(2) - Formula (9.2)

Parameters

z: MM
[z] The internal lever arm for an element with constant height, corresponding to the bending moment in the considered element. In the shear force calculation of reinforced concrete without axial force, the approximate value z = 0.9d may generally be used [mm].

alpha: DEG
[] The angle between the shear reinforcement and the longitudinal axis of the beam (see 9.2.2(1)) [deg].

theta: DEG
[] The angle between the shear compression strut and the axis of the beam 6.2.3 [C1] [deg].

formula_9_3

Formula 9.3 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_

Bases: *Formula*

Class representing the formula 9.3 for the calculation of anchorage length of bottom reinforcement at an end support using the shift rule.

label = '9.3'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*v_ed: float*, *a_l: float*, *z: float*, *n_ed: float*) → None

[FEd] Force to be anchored according to the shift rule [kN].

NEN-EN 1992-1-1+C2:2011 art.9.2.1.4(2) - Formula (9.3)

Parameters

v_ed: KN
[VEd] Design value shear force [kN].

a_l: MM
[al] Shift in the moment diagram of an element with shear reinforcement based on art. 9.2.1.3 (2) [mm]. Use your own implementation of this value or use the Form9Dot2ShiftInMomentDiagram class.

z: MM
[z] The internal lever arm for an element with constant height, corresponding to the bending moment in the considered element. In the shear force calculation of reinforced concrete without axial force, the approximate value z = 0.9d may generally be used [mm].

n_ed: KN
[NEd] Design value of axial force [kN].

formula_9_4

Formula 9.4 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_

Bases: *Formula*

Class representing the formula 9.4 for the calculation of the shear reinforcement ratio.

label = '9.4'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*a_sw: float*, *s: float*, *b_w: float*, *alpha: float*) → None

[w] Shear reinforcement ratio [-].

NEN-EN 1992-1-1+C2:2011 art.9.2.2(5) - Formula (9.4)

Parameters

a_sw: MM2
: [Asw] Area of shear reinforcement within length s [mm^2].

s: MM
: [s] The spacing between shear reinforcement along the longitudinal axis of the element [mm].

b_w: MM
: [bw] The width of the web of the element [mm].

alpha: DEG
: [] The angle between the shear reinforcement and the longitudinal axis of the beam (see 9.2.2(1)) [deg].

formula_9_5n

Formula 9.5N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_`

Bases: `Formula`

Class representing the formula 9.5N for the calculation of the minimum shear reinforcement ratio for beams.

`label = '9.5N'`

`source_document = 'NEN-EN 1992-1-1+C2:2011'`

__init__(*f_ck: float*, *f_yk: float*) → None

[w,min] Minimum shear reinforcement ratio for beams [-].

NEN-EN 1992-1-1+C2:2011 art.9.2.2(5) - Formula (9.5N)

Parameters

f_ck: MPA
: [fck] Characteristic concrete compressive cylinder strength at 28 days [MPa].

f_yk: MPA
: [fyk] Characteristic yield strength reinforcement steel [MPa].

formula_9_6n

Formula 9.6N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_

Bases: *Formula*

Class representing the formula 9.6N for the calculation of the maximum distance between shear reinforcement in longitudinal direction.

label = '9.6N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*d: float*, *alpha: float*) → None

[sl,max] Maximum distance between shear reinforcement in longitudinal direction [mm].

NEN-EN 1992-1-1+C2:2011 art.9.2.2(6) - Formula (9.6N)

Parameters

d: MM
[d] Effective height of the cross-section [mm].

alpha: DEG
[] The angle between the shear reinforcement and the longitudinal axis of the beam (see 9.2.2(1)) [deg].

formula_9_7n

Formula 9.7N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_

Bases: *Formula*

Class representing the formula 9.7N for the calculation of the maximum distance between bent-up bars in longitudinal direction.

label = '9.7N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*d: float*, *alpha: float*) → None

[sb,max] Maximum distance between bent-up bars in longitudinal direction [mm].

NEN-EN 1992-1-1+C2:2011 art.9.2.2(7) - Formula (9.7N)

Parameters

d: MM
[d] Effective height of the cross-section [mm].

alpha: DEG
[] The angle between the shear reinforcement and the longitudinal axis of the beam (see 9.2.2(1)) [deg].

formula_9_8n

Formula 9.8N from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailing of members and particular rules.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_`

Bases: *Formula*

Class representing the formula 9.8N for the calculation of the maximum distance in transverse direction between legs in a series of shear links.

label = '9.8N'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*d: float*) → None

[st,max] Maximum distance in transverse direction between legs in a series of shear links [mm].

NEN-EN 1992-1-1+C2:2011 art.9.2.2(8) - Formula (9.8N)

Parameters

d: MM
[d] Effective height of the cross-section [mm].

formula_9_9

Formula 9.9 from NEN-EN 1992-1-1+C2:2011: Chapter 9 - Detailling and specific rules.

`class blueprints.codes.eurocode.nen_en_1992_1_1_c2_2011.chapter_9_detailling_and_specific_rules.formula_`

Bases: *Formula*

Class representing the formula 9.9 for the calculation of the maximum distance between successive series of links in longitudinal direction for slabs.

label = '9.9'

source_document = 'NEN-EN 1992-1-1+C2:2011'

__init__(*d: float*, *alpha: float*) → None

[smax] Maximum distance between successive series of links in longitudinal direction for slabs [mm].

NEN-EN 1992-1-1+C2:2011 art.9.3.2(4) - Formula (9.9)

Parameters

d: MM
[d] Effective height of the cross-section [mm].

alpha: DEG
[] The angle between the shear reinforcement and the longitudinal axis of the slab (see 9.2.2(1)) [deg].

1.2.3 nen_en_1993_1_1_c2_a1_2016

NEN-EN 1993-1-1+C2+A1:2016.

blueprints.codes.eurocode.nen_en_1993_1_1_c2_a1_2016.chapter_2_basic_of_design	Package contains the formulas of chapter 2: 'Basic of design' of NEN-EN 1993-1-1+C2+A1:2016.
blueprints.codes.eurocode.nen_en_1993_1_1_c2_a1_2016.chapter_6_ultimate_limit_state	Module containing all formulas from 1993-1-1+C2+A1:2016: Chapter 6 - Ultimate limit state.

chapter_2_basic_of_design

Package contains the formulas of chapter 2: ‘Basic of design’ of NEN-EN 1993-1-1+C2+A1:2016.

blueprints.codes.eurocode.nen_en_1993_1_1_c2_a1_2016.chapter_2_basic_of_design.formula_2_2	Formula 2.2 from NEN-EN 1993-1-1+C2+A1:2016: Chapter 2: Basis of design.

formula_2_2

Formula 2.2 from NEN-EN 1993-1-1+C2+A1:2016: Chapter 2: Basis of design.

class blueprints.codes.eurocode.nen_en_1993_1_1_c2_a1_2016.chapter_2_basic_of_design.formula_2_2.**Form2D**

Bases: *Formula*

Class representing formula 2.2 for the calculation of the characteristic value of the resistance R_k.

label = '2.2'

source_document = 'NEN-EN 1993-1-1+C2+A1:2016'

__init__(*r_d: float*, *gamma_mi: float*) → None

[R_k] Characteristic value of the resistance [kN].

NEN-EN 1993-1-1+C2+A1:2016 art.2.5(2) - Formula (2.2)

Parameters

r_d
[float] [R_d] Design value of the resistance according to Annex D of EN 1990.

gamma_mi
[DIMENSIONLESS] [$_{Mi}$] Recommended partial factors for the resistance.

chapter_6_ultimate_limit_state

Module containing all formulas from 1993-1-1+C2+A1:2016: Chapter 6 - Ultimate limit state.

blueprints.codes.eurocode.nen_en_1993_1_1_c2_a1_2016.chapter_6_ultimate_limit_state.formula_6_5	Formula 6.5 from NEN-EN 1993-1-1+C2+A1:2016: Chapter 6 - Ultimate limit state.

formula_6_5

Formula 6.5 from NEN-EN 1993-1-1+C2+A1:2016: Chapter 6 - Ultimate limit state.

class blueprints.codes.eurocode.nen_en_1993_1_1_c2_a1_2016.chapter_6_ultimate_limit_state.formula_6_5.**F**

Bases: *Formula*

Class representing formula 6.5 for the unity check for tensile strength.

label = '6.5'

source_document = 'NEN-EN 1993-1-1+C2+A1:2016'

__init__(*n_ed: float*, *n_t_rd: float*) → None

[N_ed/N_t_rd] Unity check for tensile strength of an element in tension.

NEN-EN 1993-1-1+C2+A1:2016 art.6.2.3(1) - Formula (6.5)

Parameters

n_ed
[KN] [NEd] Design value of the normal tensile force [kN].

n_t_rd
[KN] [Nt,Rd] Design value of the resistance against tenslie force [kN].

1.2.4 nen_en_1993_5_2008

NEN-EN 1993-5:2008.

blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states	Module containing all formulas from 1993-5:2008 Chapter 5 - Ultimate limit states.

chapter_5_ultimate_limit_states

Module containing all formulas from 1993-5:2008 Chapter 5 - Ultimate limit states.

blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_10	Formula 5.10 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.
blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_2	Formula 5.2 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.
blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_3	Formula 5.3 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.
blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_5	Formula 5.5 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.
blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_6	Formula 5.6 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.
blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_7	Formula 5.7 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.
blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_8	Formula 5.8 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.
blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_9	Formula 5.9 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.

formula_5_10

Formula 5.10 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.

class blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_10.**Form5Do**

Bases: *Formula*

Class representing formula 5.10 for reduction factor for shear area.

label = '5.10'

source_document = 'NEN-EN 1993-5:2008'

__init__(*v_ed: float*, *v_pl_rd: float*) → None

[] Calculate the reduction factor for shear area of the cross-section [-].

NEN-EN 1993-5:2008(E) art.5.2.2(9) - Formula (5.10)

Parameters

v_ed
[KN] [V_{Ed}] Design shear force in [kN].

v_pl_rd
[KN] [$V_{pl,rd}$] Plastic shear resistance in [kN].

latex() → *LatexFormula*
Returns LatexFormula object for formula 5.10.

Return type
LatexFormula

formula_5_2

Formula 5.2 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.

class blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_2.**Form5Dot2**

Bases: `Formula`

Class representing formula 5.2 for design moment resistance for Class 1 or 2 cross-sections.

label = '5.2'

source_document = 'NEN-EN 1993-5:2008'

__init__(*beta_b: float*, *w_pl: float*, *f_y: float*, *gamma_m_0: float*) → None
($M_{c,Rd}$) Calculate design moment resistance of the cross-section (class 1 or 2) in [kNm/m].

NEN-EN 1993-5:2008(E) art.5.2.2(2) - Formula (5.2)

Parameters

beta_b
[DIMENSIONLESS] ($_b$) Reduction factor for the bending resistance of the cross-section in [-].

w_pl
[MM3] (W_{pl}) Plastic section modulus in [mm/m].

f_y
[MPA] (f_y) Yield strength in [MPa].

gamma_m_0
[DIMENSIONLESS] ($_{M0}$) Partial factor for material properties in [-].

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.2.

Return type

LatexFormula

formula_5_3

Formula 5.3 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.

class blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_3.**Form5Dot**

Bases: *Formula*

Class representing formula 5.3 for design moment resistance for Class 3 cross-sections.

label = '5.3'

source_document = 'NEN-EN 1993-5:2008'

__init__(*beta_b: float*, *w_el: float*, *f_y: float*, *gamma_m_0: float*) → None

($M_{c,Rd}$) Calculate design moment resistance of the cross-section (class 3) in [kNm/m].

NEN-EN 1993-5:2008(E) art.5.2.2(2) - Formula (5.3)

Parameters

beta_b

[DIMENSIONLESS] ($_{b}$) Reduction factor for the bending resistance of the cross-section in [-].

w_el

[MM3] (W_{el}) Elastic section modulus in [mm/m].

f_y

[MPA] (f_y) Yield strength in [MPa].

gamma_m_0

[DIMENSIONLESS] ($_{M0}$) Partial factor for material properties in [-].

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.3.

Return type

LatexFormula

formula_5_5

Formula 5.5 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.

class blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_5.**Form5Dot5**

Bases: *Formula*

Class representing formula 5.5 for the design plastic shear resistance for each web.

label = '5.5'

source_document = 'NEN-EN 1993-5:2008'

__init__(*a_v: float*, *f_y: float*, *gamma_m_0: float*) → None

($V_{pl,Rd}$) Calculate design plastic shear resistance for each web in [kN].

NEN-EN 1993-5:2008(E) art.5.2.2(4) - Formula (5.5)

Parameters

a_v
[MM2] (A_v) Projected shear area for each web, acting in the same direction as VEd in [mm].

f_y
[MPA] (f_y) Yield strength in [MPa].

gamma_m_0
[DIMENSIONLESS] ($_{M0}$) Partial factor for material properties in [-].

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.5.

Return type
LatexFormula

formula_5_6

Formula 5.6 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.

class blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_6.**Form5Dot6**

Bases: *Formula*

Class representing formula 5.6 for the projected shear area for each web of a U-profile or Z-profile.

label = '5.6'

source_document = 'NEN-EN 1993-5:2008'

`__init__`(*h: float*, *t_f: float*, *t_w: float*) → None

[A_v] Calculate the projected shear area for each web of a U-profile or Z-profile in [mm].

NEN-EN 1993-5:2008(E) art.5.2.2(5) - Formula (5.6)

Parameters

h
[MM] [h] Overall height in [mm].

t_f
[MM] [t_f] Flange thickness in [mm].

t_w
[MM] [t_w] Web thickness in [mm].

`latex`() → *LatexFormula*

Returns LatexFormula object for formula 5.6.

Return type
LatexFormula

formula_5_7

Formula 5.7 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.

class `blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_7.Form5Dot`

Bases: `Formula`

Class representing formula 5.7 for shear buckling resistance.

label = '5.7'

source_document = 'NEN-EN 1993-5:2008'

`__init__`(*h: float*, *t_f: float*, *t_w: float*, *f_bv: float*, *gamma_m_0: float*) → None

[$V_{b,Rd}$] Calculate the shear buckling resistance [kN].

NEN-EN 1993-5:2008(E) art.5.2.2(7) - Formula (5.7)

Parameters

h
[MM] [h] Height of the web in [mm].

t_f
[MM] [t_f] Thickness of the flange in [mm].

t_w
[MM] [t_w] Thickness of the web in [mm].

f_bv
[MPA] [f_{bv}] Shear buckling strength according to Table 6-1 of EN 1993-1-3 for a web without stiffening at the support and for a relative web slenderness [MPa]

gamma_m_0
[float] [$_{M0}$] Partial factor for material properties [-].

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.7.

Return type
LatexFormula

formula_5_8

Formula 5.8 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit states.

class `blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_8.Form5Dot8`

Bases: `Formula`

Class representing formula 5.8 for relative slenderness of the web.

label = '5.8'

source_document = 'NEN-EN 1993-5:2008'

__init__(*c: float*, *t_w: float*, *f_y: float*, *e: float*) → None

[$\bar{\lambda}$] Calculate the relative slenderness of the web [-].

NEN-EN 1993-5:2008(E) art.5.2.2(7) - Formula (5.8)

Parameters

c
[MM] [c] Length of the web in [mm].

t_w
[MM] [t_w] Thickness of the web in [mm].

f_y
[MPA] [f_y] Yield strength in [MPa].

e
[MPA] [E] Young's modulus in [MPa].

latex() → *LatexFormula*

Returns LatexFormula object for formula 5.8.

Return type
LatexFormula

formula_5_9

Formula 5.9 from NEN-EN 1993-5:2008 Chapter 5 - Ultimate limit state.

`class blueprints.codes.eurocode.nen_en_1993_5_2008.chapter_5_ultimate_limit_states.formula_5_9.Form5Dot9`

Bases: *Formula*

Class representing formula 5.9 for reduced design bending moment resistance of the cross-section.

`label = '5.9'`

`source_document = 'NEN-EN 1993-5:2008'`

`__init__`(*beta_b: float*, *w_pl: float*, *rho: float*, *a_v: float*, *t_w: float*, *alpha: float*, *f_y: float*, *gamma_m_0: float*, *mc_rd: float*) → None

($M_{V,Rd}$) Calculate reduced design bending moment resistance of the cross-section allowing for the shear force in $[kNm]$.

This calculation is specifically for sheet pile cross-sections, particularly U-profiles and Z-profiles.

NEN-EN 1993-5:2008(E) art.5.2.2(9) - Formula (5.9)

Parameters

beta_b
[DIMENSIONLESS] ($_b$) Reduction factor for the bending resistance of the cross-section, which takes account of possible lack of shear force transmission in the interlocks [-]. Defined in NEN-EN 1993-5:2008(E) art. 5.2.2(2) or CUR166, part 2, par. 3.3.2.

w_pl
[MM3] (W_{pl}) Plastic section modulus in $[mm]$.

rho
[DIMENSIONLESS] () Reduction factor for shear resistance of the cross-section, according NEN-EN 1993-5:2008(E) art. 5.2.2(9) formula 5.10 [-].

a_v
[MM2] (A_V) Projected shear area for each web, acting in the same direction as VEd in $[mm]$.

t_w
[MM] (t_w) Thickness of the web in $[mm]$.

alpha
[DEGREE] () the inclination of the web according to NEN-EN 1993-5:2008(E) Figure 5-1 in [degrees].

f_y
[MPA] (f_y) Yield strength in $[MPa]$.

gamma_m_0
[DIMENSIONLESS] ($_{M0}$) Partial factor for material properties in [-].

mc_rd
[KNM] ($M_{c,Rd}$) Design moment resistance of the cross-section in $[kNm]$.

The *mc_rd* parameter represents the design moment resistance of the cross-section. In the context of the formula for reduced bending moment resistance, it serves as an upper bound. The formula calculates the reduced design bending moment resistance (*m_v_rd*) and then returns the minimum of *m_v_rd* and *mc_rd*. This means that the result of the formula will never exceed *mc_rd*, making *mc_rd* an upper bound for this formula.

$M_{v,Rd} <= M_{c,Rd}$

`latex()` → *LatexFormula*

Returns LatexFormula object for formula 5.9.

Return type

LatexFormula

1.3 formula

Module for the abstract base class Formula.

`class blueprints.codes.formula.Formula(*args, **kwargs)`

Bases: `float`, `ABC`

Abstract base class for formulas used in the codes.

Return type

Formula

`__init__(*args, **kwargs)` → None

Method for initializing a new instance of the class.

`abstract property label: str`

Property for the formula label.

For example, "5.2" for formula 5.2.

1.3.1 Returns

str

The label/number associated with the formula. This is an abstract method and must be implemented in all subclasses.

`abstract property source_document: str`

Property for the source document.

For example, "NEN-EN 1992-1-1+C2:2011" Try to use the official and complete name of the document including publishing year, if possible.

1.3.2 Returns

str

The reference to the document where the formula originates. This is an abstract method and must be implemented in all subclasses.

property detailed_result: dict

Property for providing the detailed result of the formula.

1.3.3 Returns

dict

The detailed result of the formula. Keys are strings representing the name of the partial or intermediate result. Values types will depend on the specific implementation, but must be a serializable type.

1.4 latex_formula

Latex formula representation.

class blueprints.codes.latex_formula.**LatexFormula**(*return_symbol: str, result: str, equation: str = '', numeric_equation: str = '', comparison_operator_label: str = '='*)

Bases: object

Latex formula representation. Depending on the context this could include the unit, the formula, the result, etc.

1.4.1 Attributes

return_symbol: str

The symbol to return

result: str

The result of the formula

equation: str, default ""

The formula with symbols

numeric_equation: str, default ""

The formula with values (numbers)

comparison_operator_label: str, default "="

The label for the comparison operators between the return symbol and the result. Could be changed for inequalities.

return_symbol: str

result: str

equation: str = ''

numeric_equation: str = ''

comparison_operator_label: str = '='

property complete: str

Complete representation of the formula.

Returns

str
Return symbol = equation = numeric_equation = result

property short: str

Minimal representation of the formula.

Returns

str
Return symbol = result

blueprints.codes.latex_formula.**latex_fraction**(*numerator: str | float, denominator: str | float*) → str

Return a string which will output: frac{numerator}{denominator} in latex.

1.4.2 Examples

```
>>> latex_fraction(1, 2)
str(\frac{1}{2})
```

1.4.3 Parameters

numerator: str | float
The numerator of the fraction.

denominator: str | float
The denominator of the fraction.

1.4.4 Returns

str
The latex string

Return type
str

blueprints.codes.latex_formula.**latex_min_curly_brackets**(**args: str | float*) → str

Return a string which will output: min{arg_1; arg_2; …; arg_N} in latex and it will also automatically ensure floats are converted to latex text.

1.4.5 Examples

```
>>> latex_min_curly_brackets(1, 2)
str(\min \left\{1; 2\right\})
```

1.4.6 Parameters

args: str
The arguments of the min function.

1.4.7 Returns

str
The latex representation of the min function.

Return type
str

blueprints.codes.latex_formula.**latex_max_curly_brackets**(**args: str | float*) → str

Return a string which will output: max{arg_1; arg_2; …; arg_N} in latex and it will also automatically ensure floats are converted to latex text.

1.4.8 Examples

```
>>> latex_max_curly_brackets(1, 2)
str(\max \left\{1; 2\right\})
```

1.4.9 Parameters

args: str
The arguments of the max function.

1.4.10 Returns

str
The latex representation of the max function.

Return type
str

CHAPTER

TWO

TYPE_ALIAS

Module to keep track of type aliases used in Blueprints.

CHAPTER

THREE

UNIT_CONVERSION

Module for unit conversions inside of Blueprints.

CHAPTER

FOUR

VALIDATIONS

Module for validation actions inside of Blueprints.

exception blueprints.validations.**LessOrEqualToZeroError**(*value_name: str*, *value: float*)

Bases: Exception

Raised when a value is less than or equal to zero.

exception blueprints.validations.**NegativeValueError**(*value_name: str*, *value: float*)

Bases: Exception

Raised when a value is negative.

exception blueprints.validations.**GreaterThan90Error**(*value_name: str*, *value: float*)

Bases: Exception

Raised when a value is greater than 90.

blueprints.validations.**raise_if_less_or_equal_to_zero**(***kwargs: float*) → None

Raise a LessOrEqualToZeroError if any of the given keyword arguments are less than or equal to zero.

4.1 Parameters

****kwargs**

[dict[str, float]] A dictionary of keyword arguments where keys are parameter names, and values are the values to validate.

4.2 Raises

LessOrEqualToZeroError

If any value is less than or equal to zero.

blueprints.validations.**raise_if_negative**(***kwargs: float*) → None

Raise a NegativeValueError if any of the given keyword arguments are negative.

4.3 Parameters

****kwargs**
: [dict[str, float]] A dictionary of keyword arguments where keys are parameter names, and values are the values to validate.

4.4 Raises

NegativeValueError
: If any value is negative.

`blueprints.validations.raise_if_greater_than_90(**kwargs: float) → None`

Raise a GreaterThan90Error if any of the given keyword arguments are greater than 90.

4.5 Parameters

****kwargs**
: [dict[str, float]] A dictionary of keyword arguments where keys are parameter names, and values are the values to validate.

4.6 Raises

GreaterThan90Error
: If any value is greater than 90.

CHAPTER

FIVE

WELCOME TO BLUEPRINTS

The cornerstone repository for civil engineering professionals and enthusiasts alike. Blueprints is a collaborative, open-source initiative designed to serve as a comprehensive library of code, tools, and best practices, aiming to streamline and innovate the workflows within the built environment sector.

5.1 Vision

Our vision with Blueprints is to create an accessible, reliable, and community-driven resource that supports engineers, and developers in their daily challenges. By harnessing the collective expertise of the industry, Blueprints strives to pave the way for a future where collaboration and open source can drive the field of civil engineering to new heights.

5.2 Mission

Our mission is to:

- Foster a community where sharing knowledge and best practices is the norm, not the exception.
- Provide a solid foundation of code and documentation that adheres to the highest quality standards (100% code coverage).
- Offer a robust suite of tools and libraries that encapsulate common and advanced engineering tasks.

5.3 Installation

For the last release:

```
pip install blue-prints
```

For the actively developed version:

```
pip install git+https://github.com/Blueprints-org/blueprints.git
```

5.4 Contributing

Contributions are very welcome. To learn more, see the Contributor Guide. A list of the current features of the package and implementation goals for future releases can be found in the README file on github.

5.5 License

Blueprints is free and open source software. Distributed under the terms of the LGPL-2.1 license.

5.6 Support

If you have found a bug , or have a feature request , raise an issue on the GitHub issue tracker. Alternatively you can get support on the discussions page.

5.7 Disclaimer

Blueprints is an open source engineering tool that continues to benefit from the collaboration of many contributors. Although efforts have been made to ensure the that relevant engineering theories have been correctly implemented, it remains the user's responsibility to confirm and accept the output. Refer to the license for clarification of the conditions of use.

PYTHON MODULE INDEX

b

INDEX

Symbols

C

D

E

F

G

L

N

R

S