Structural Steel and Timber Design SAB3233

Topic 4
Design of steel structures (BS EN 1993)

Prof Dr Shahrin Mohammad

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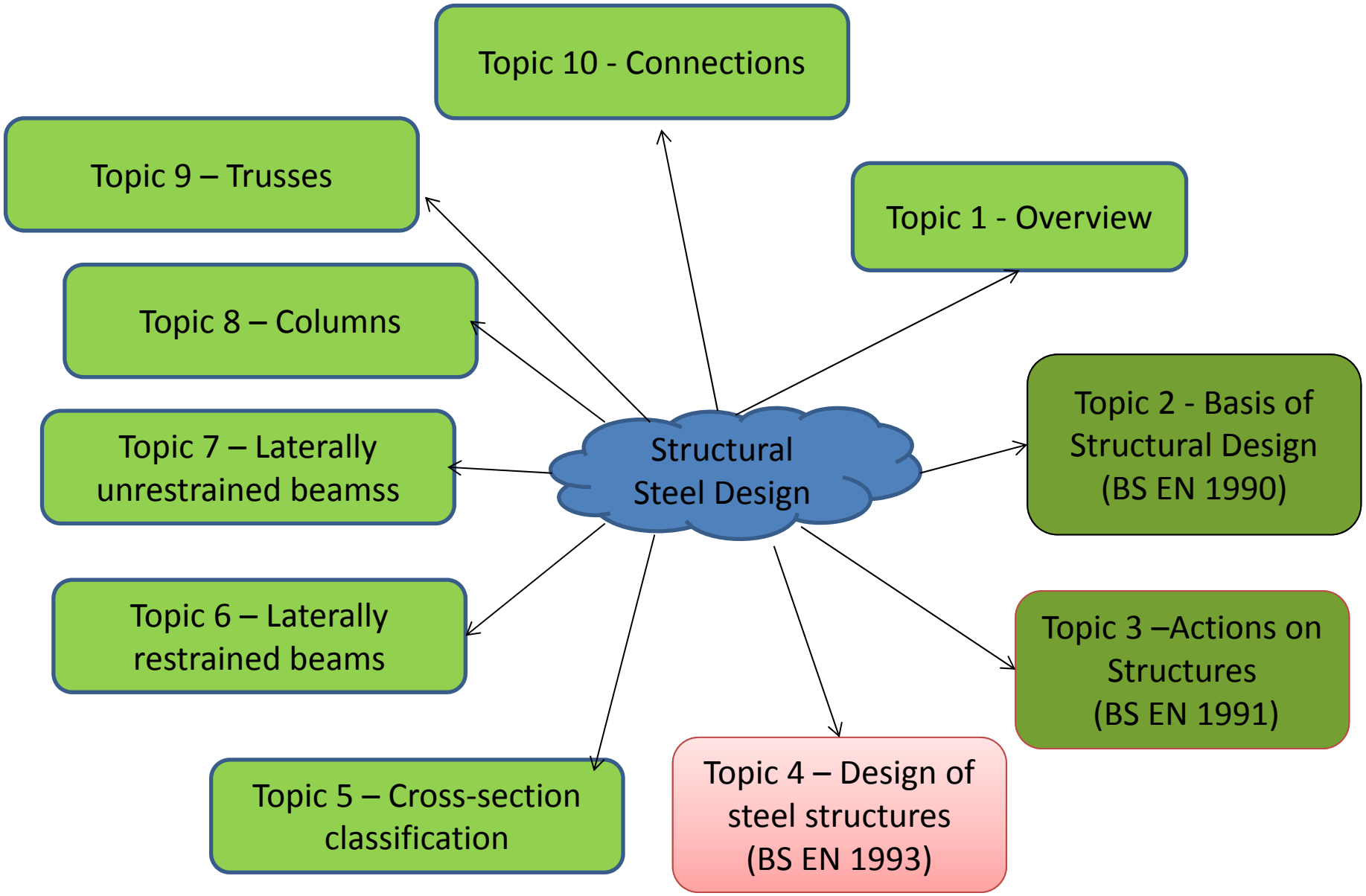
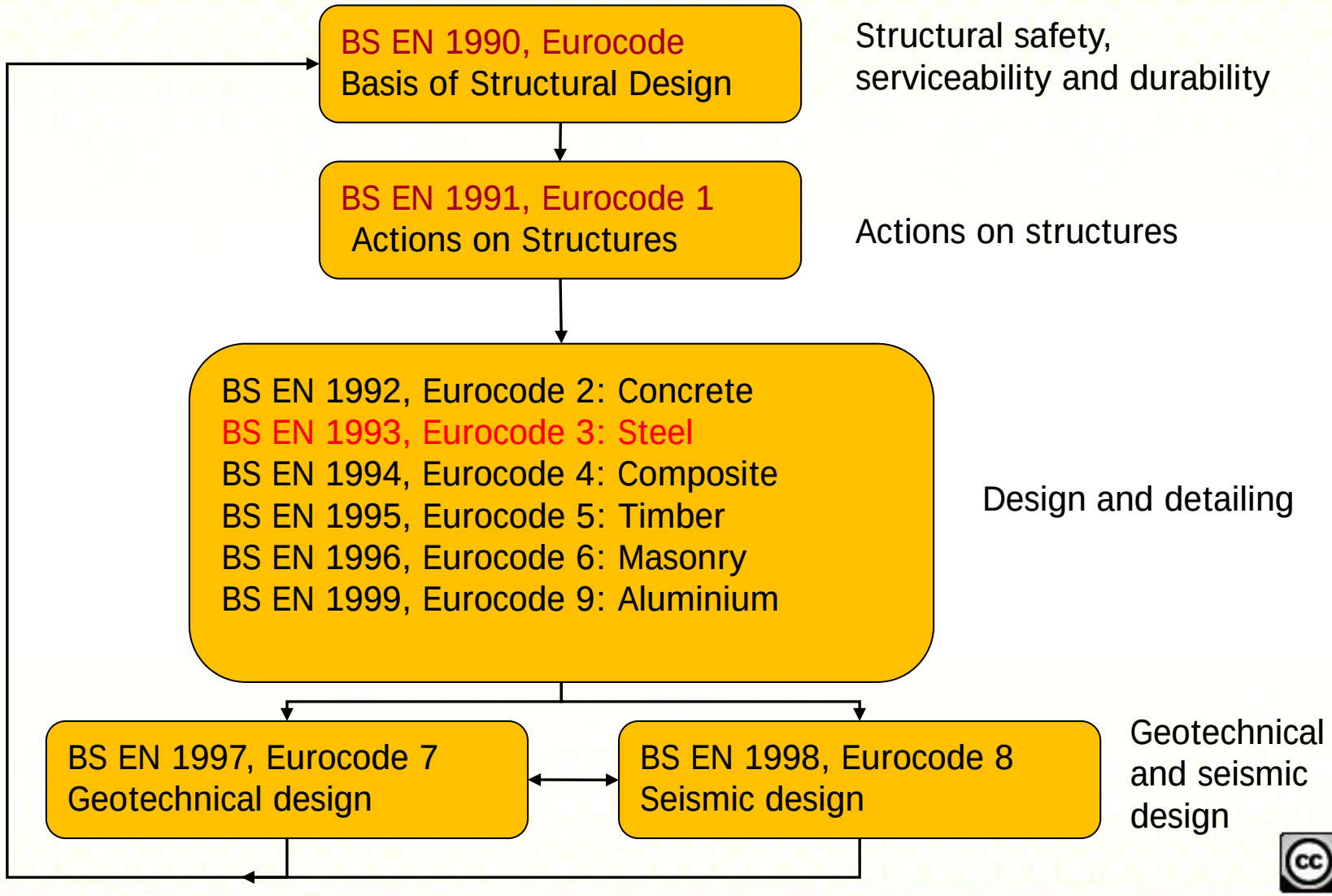

Topic 10 - Connections
Topic 9 – Trusses
Topic 1 - Overview
Topic 8 – Columns
Topic 2 - Basis of Structural Design (BS EN 1990)
Topic 7 – Laterally unrestrained beamss
Structural Steel Design
Topic 6 – Laterally restrained beams
Topic 3 –Actions on Structures (BS EN 1991)
Topic 5 – Cross-section classification
Topic 4 – Design of steel structures (BS EN 1993)

Structural Eurocodes- an overview



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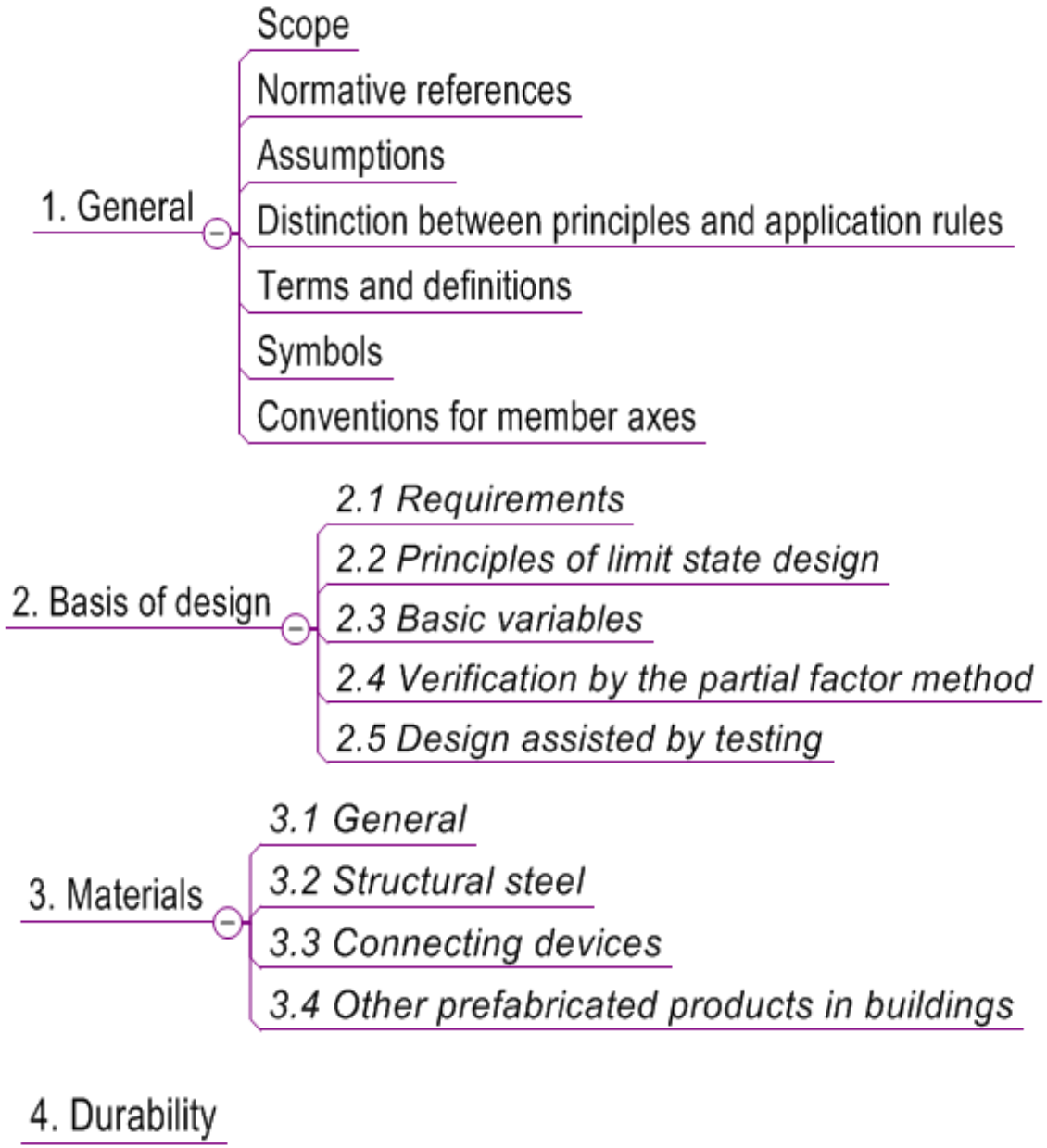
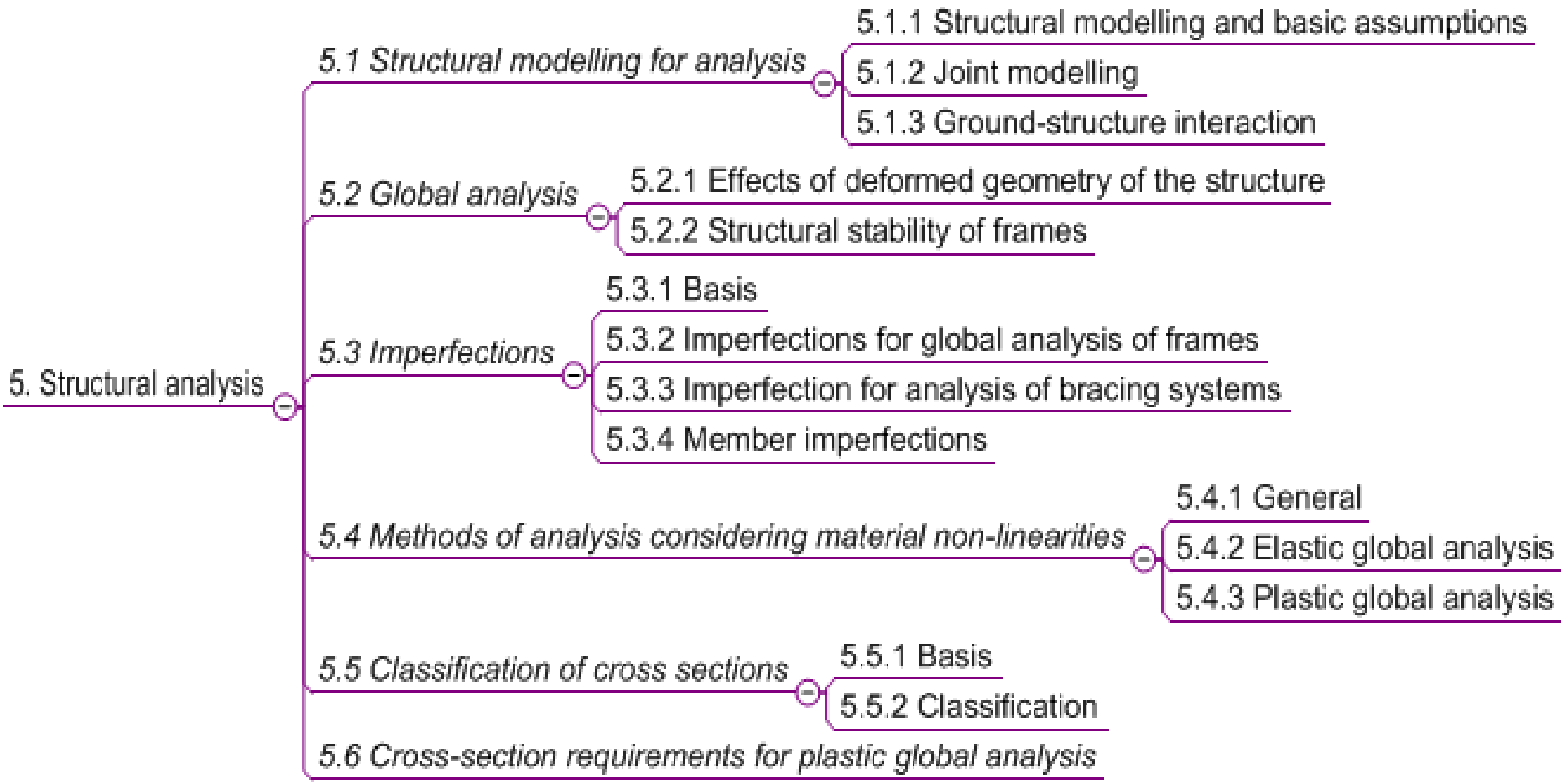
Eurocode 3 : Design of steel structures – Part 1-1: General rules and rules for Buildings BS EN 1993-1-1:2005

Eurocode 3 : Content



Eurocode 3 : Content



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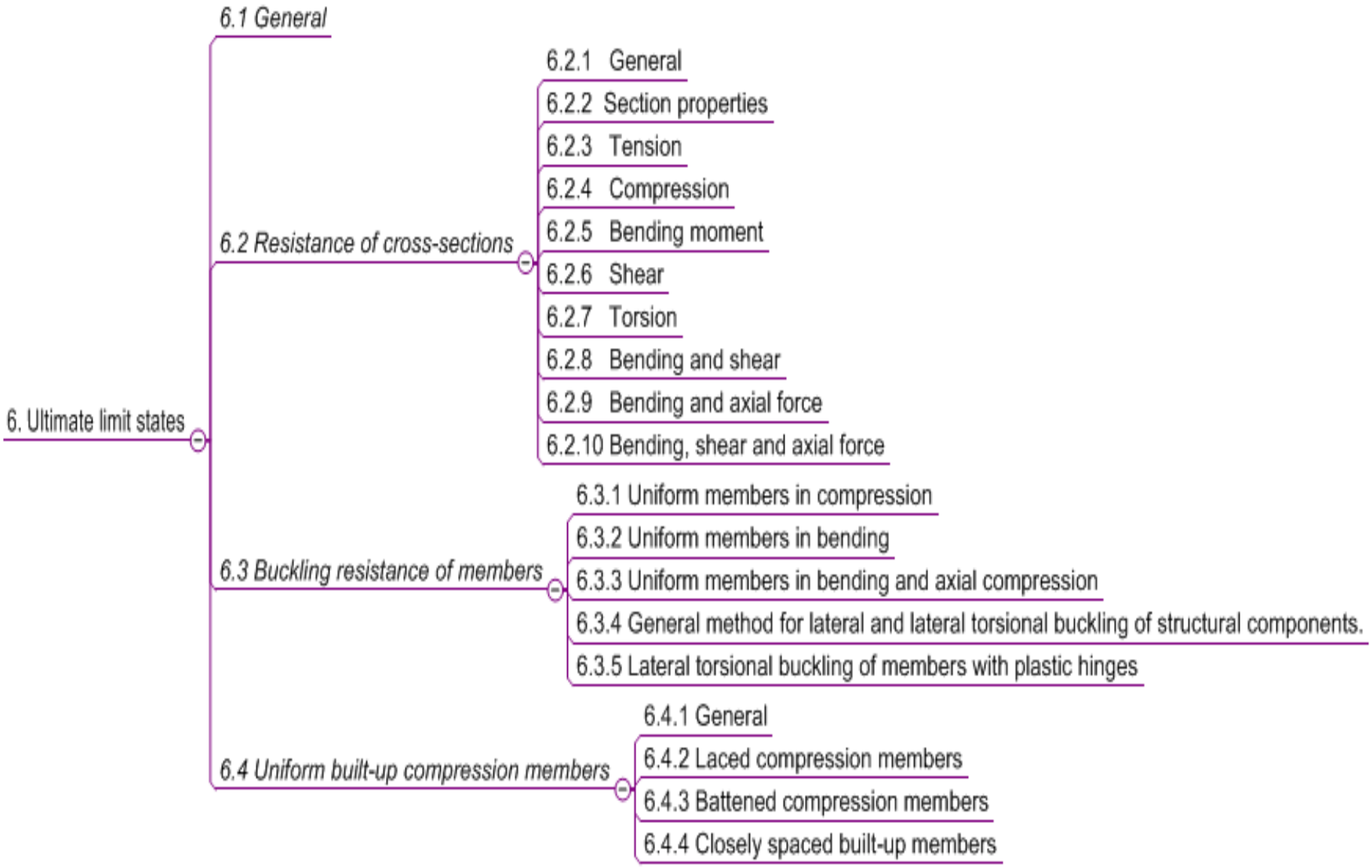

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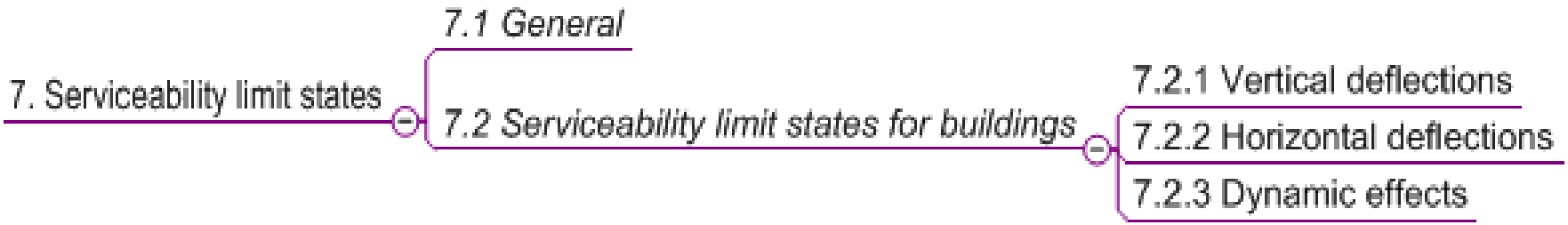

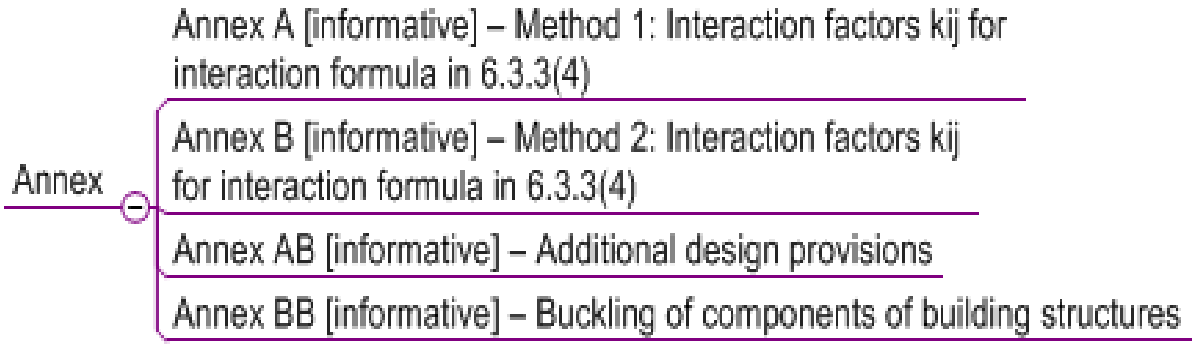

- the principles of design, concept and formulation are generally similar to BS5950
- the main differences of the two design rules are only in the symbols, terms, safety factors and limits adopted
- distinction is made between
  - principles which must be obeyed
  - application rules which follow the principles but alternative methods are allowed
- design capacities in EC3 are categorised under cross-section resistance and member buckling resistance (based on structural behaviour and not based on element/member)

- based on limit state design principles which require that specific 'failure' conditions must be checked for both ultimate and serviceability conditions
- variability, principally of actions and materials, is accounted for by partial safety factors which also incorporate a global margin of safety
- EC3 incorporates theories in the first-order and second order which consider the effects of deformations
- EC3 allows us to choose the degree of accuracy of the structural analysis
- allows for the “advanced analysis approach” in analysis and design as an alternative to simplified design method

- frame imperfection(P-D and P-d effect) to be included in the structural modeling of frames
- a comprehensive information on the elastic-perfectly plastic and elasto-plastic methods for continuous and semi-continuous steel framing
- providing classification of the connections based on strength and rigidity
- the information on frame stability is presented in detailed whilst the terms sway and non-sway frames are well defined

Distinction between principles and application rules

(1) The Principles comprise :
- general statements and definitions for which there is no alternative
- requirements and analytical models for which no alternative is permitted

(2) The Principles are identified by the letter P following the paragraph number.

(3) The Application Rules are generally recognised rules which comply with the Principles and satisfy their requirements.

(4) It is permissible to use alternative design rules different from the application Rules given in EN 1990 for works, provided that it is shown that the alternative rules accord with the relevant Principles and are at least equivalent with regard to the structural safety, serviceability and durability which would be expected when using the Eurocodes.

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2.1 Requirements

(1) P The design of steel structures shall be in accordance with the general rules given in EN 1990.

2.2 Principles of limit state design

Limit states - states beyond which the structure no longer fulfils the relevant design criteria

Ultimate limit states – states associated with collapse or with other similar forms of structural failure. Ultimate limit state, concerned with ‘collapse’ like yielding, buckling and overturning.

The following conditions should be considered:

1. Stability: overturning (equilibrium)
2. Strength: including local and overall buckling effects where appropriate

Serviceability limit states – states that correspond to conditions beyond which specified service requirements for a structure or structural member are no longer met. Serviceability limit state, concerned with ‘function’: like deflection and vibration.

Both conditions are associated with stiffness rather than strength. For most buildings, controlling deflections will also limit vibrations

Partial safety factors are applied to characteristic values to obtain design values

Suffices k and d are used to signify characteristic and design values respectively

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ULS

Load combinations can be simplified as:

1,35 Gk + 1,5 Qk	where Qk is the dominant imposed load, and
1,35 Gk + 1,35Qk	where there are more than one imposed loads

Where loads have a beneficial effect: 0.9 Gk

SLS

Load combinations can be simplified as:

1,0 Gk + 1,0 Qk	where Qk is the dominant imposed load, and
1,0 Gk + 0,9 Qk	where there are more than one imposed loads

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Analyse using appropriate methods and accounting for variability to determine:

1. Design effects {E}, and
2. Design resistance {R}

Ensure no limit state is exceeded {R > E}

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Eurocode 3 – Design Checks

- Design checks are required and it depends on the type of structure
- Frames are checked for
  - Static equilibrium
  - Frame stability
  - Resistance of cross-sections
  - Resistance of members
  - Resistance of joints
- Tension members need only checked for resistance of cross-sections

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2.3 Basic variables

2.3.1 Actions and environmental influences

2.3.2 Material and product properties

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