

Failure analysis on timber structures in Germany

Recording data and pointing the way statements

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Motivation

- At the beginning of 2006 many timber structures in Germany collapsed
 - What are the causes of the failures ?
 - Which mutual relations can be shown ?
 - building use, structures, material, load, damage, cause of the fault etc
- Looking for answers to research questions



Objective

- Integral statistical and systematic reflection of failures concerning timber hall structures
 - Building up a database
 - Development of a system to be able to access, to analyse and to show the data
- Detailed information: Blaß & Frese 2007 (report will be published by Universitätsverlag Karlsruhe)



Recording data – in general

- Timber hall structures are well comparable to each other
(structural parts and construction principles)
- Data coming from numerous expert's reports
 - Data contain the angles of numerous experts
 - Leads to a valuable set of know-how



Recording data – the method

- Excel sheet
- Keywords
- Problem-oriented statistical analysis system
 - Quick and reliable data capture
 - Evaluation and representation is easily possible in the future



Main structuring

data

building parameters

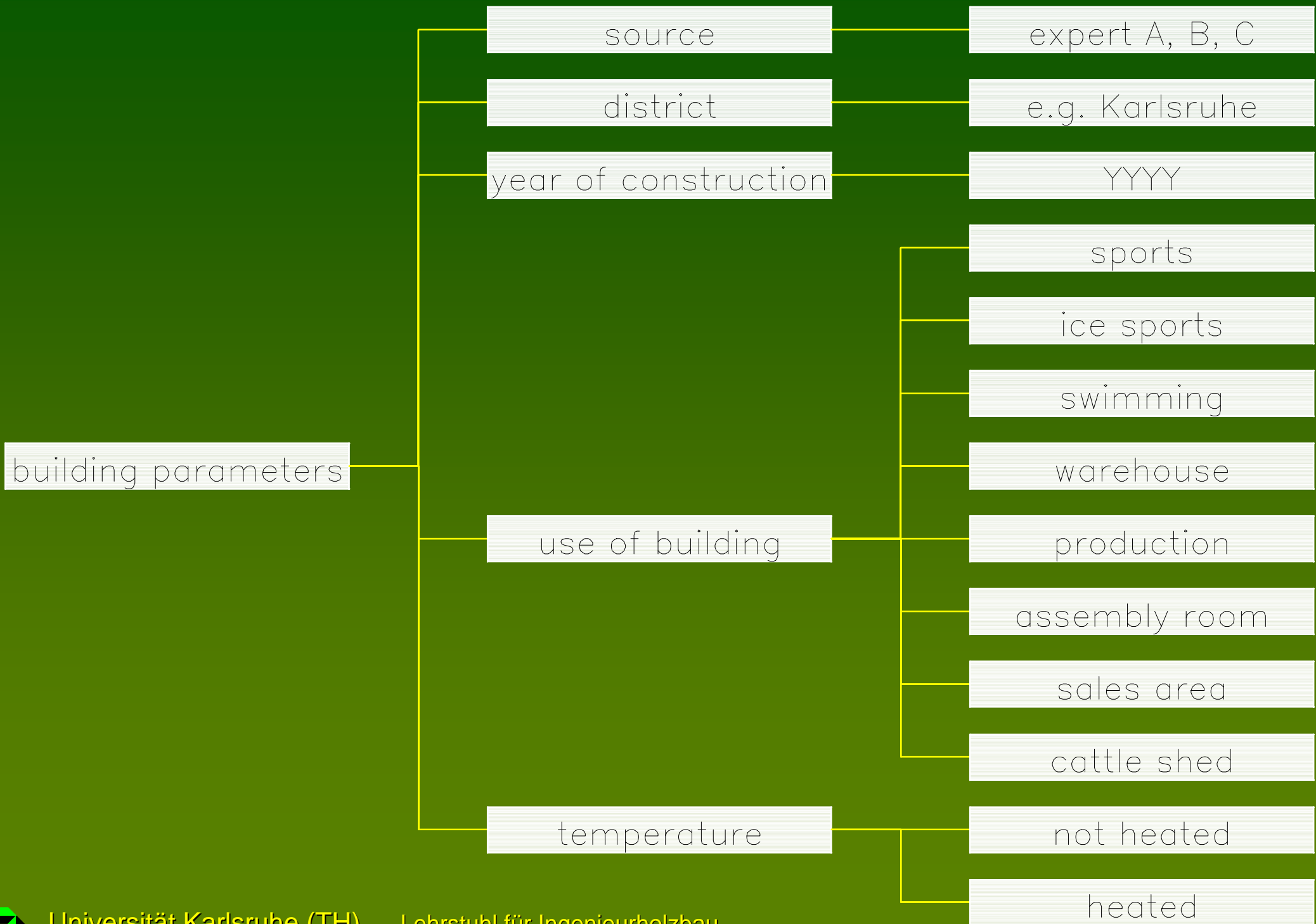
component parameters

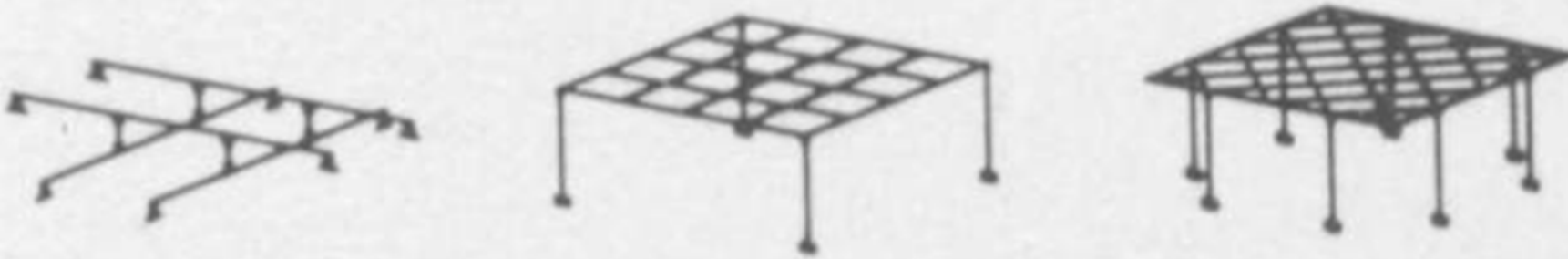
material parameters

damage parameters

cause of the fault







component parameters

affected bearing system

bearing system span

affected component

moisture content

simply supported beam

continuously supported beam

cantilever

structure with hinges

frame

arc

grating

truss

in m

flexural member

flex. member with compression

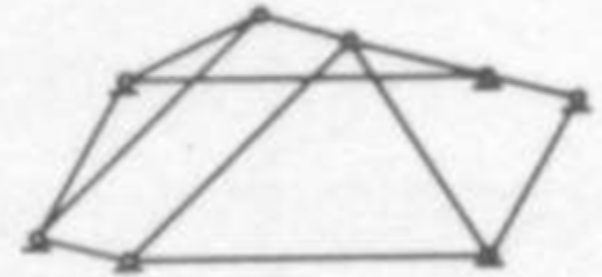
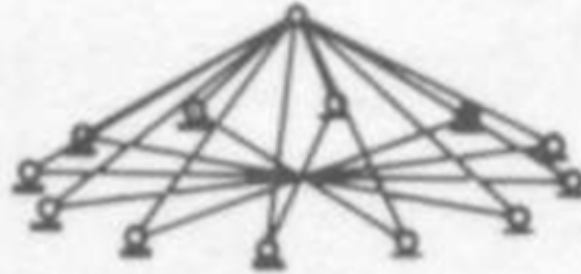
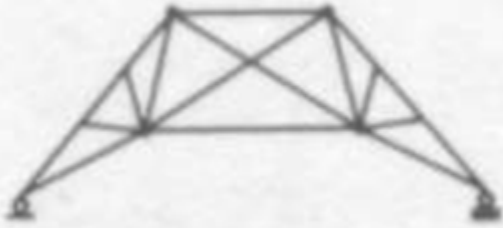
compression member

tension member

compression member with flexure

in %





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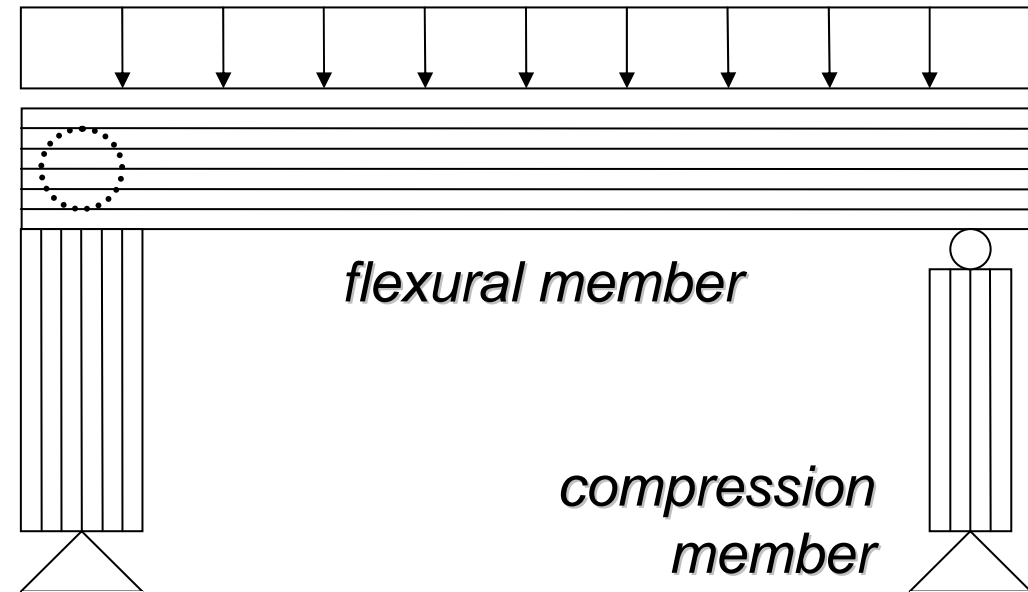
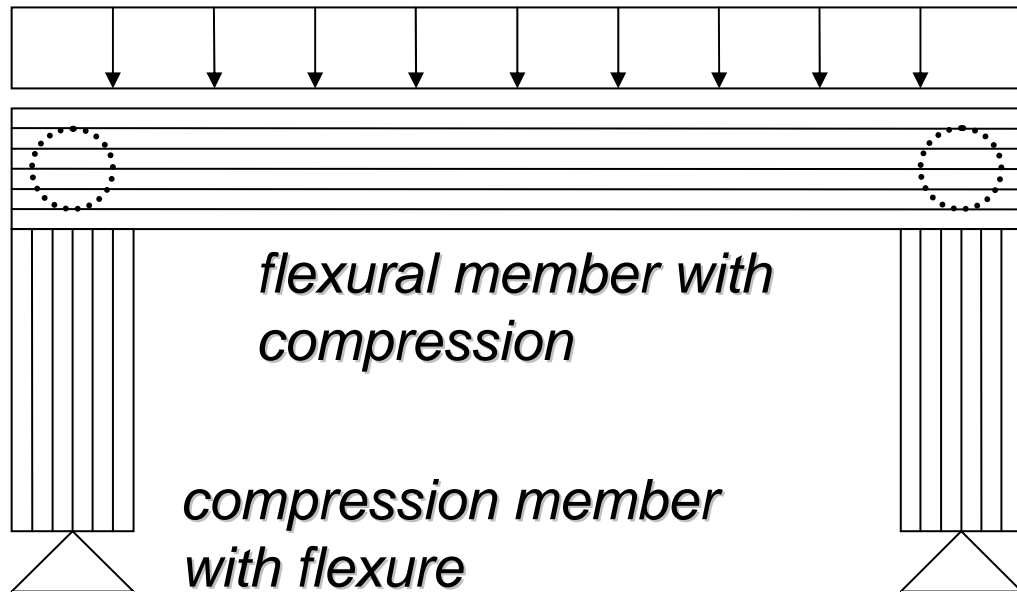
compression member

tension member

compression member with flexure

in %









damage parameters

primary damage

stability assessment

critical distortion

soaked

decay

change in colour

crack in grain direction

shear failure

tension failure

without

ensured

ensured with reservation

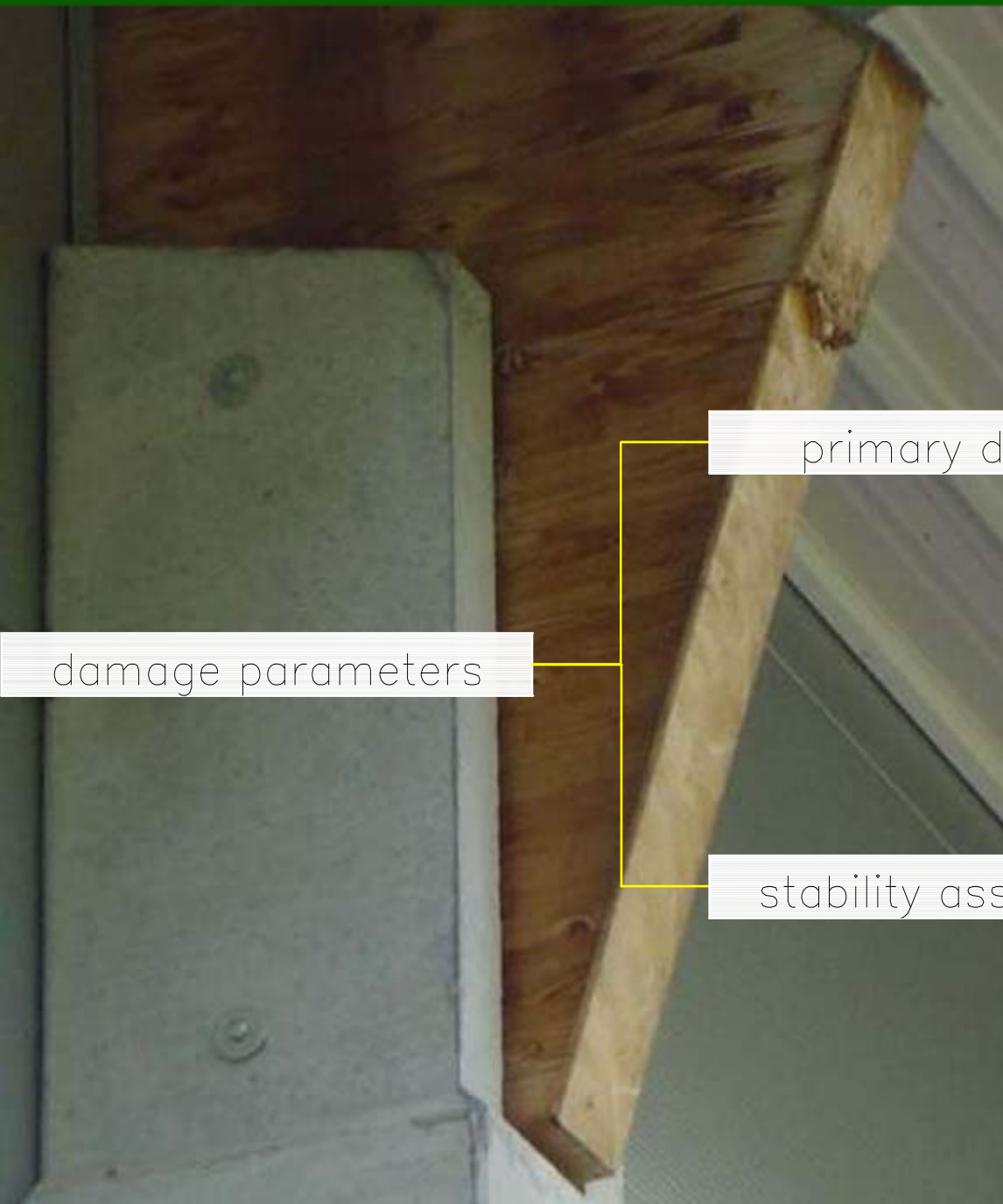
at risk

component failure

component collapse

construction collapse





damage parameters

primary damage

stability assessment

- critical distortion
- soaked
- decay
- change in colour
- crack in grain direction
- shear failure
- tension failure
- without
- ensured
- ensured with reservation
- at risk
- component failure
- component collapse
- construction collapse





damage parameters

primary damage

stability assessment

critical distortion

soaked

decay

change in colour

crack in grain direction

shear failure

tension failure

without

ensured

ensured with reservation

at risk

component failure

component collapse

construction collapse



causes of the fault

planning

carrying out

assembly/erection

building physics

load

construction

material quality

moisture

insects

alternating climates

shrinking or swelling

maintenance

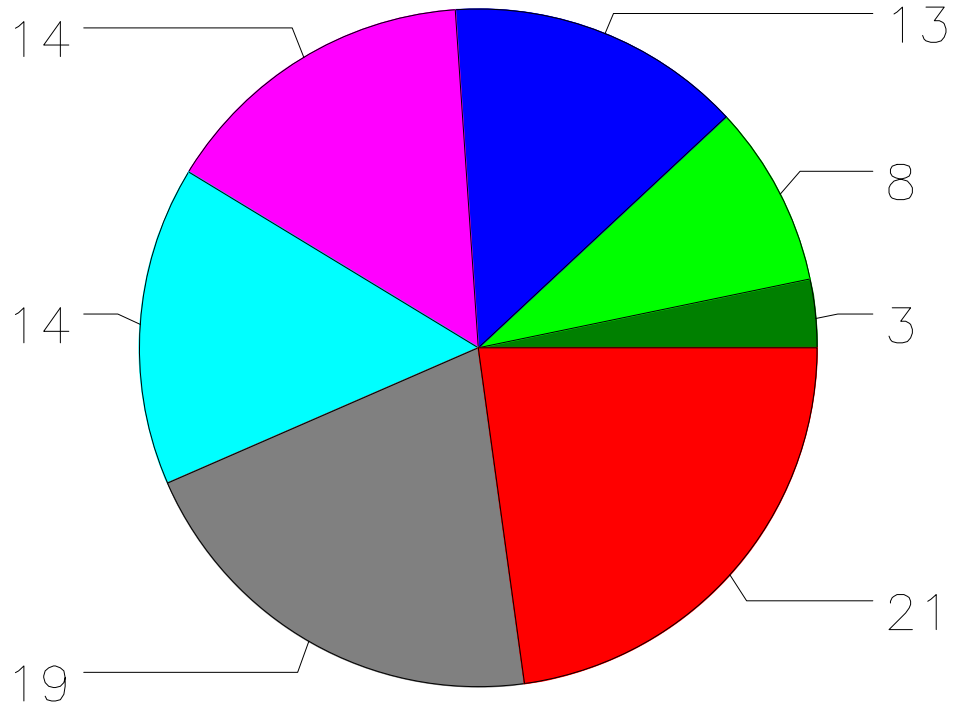


Description of the buildings and their failures

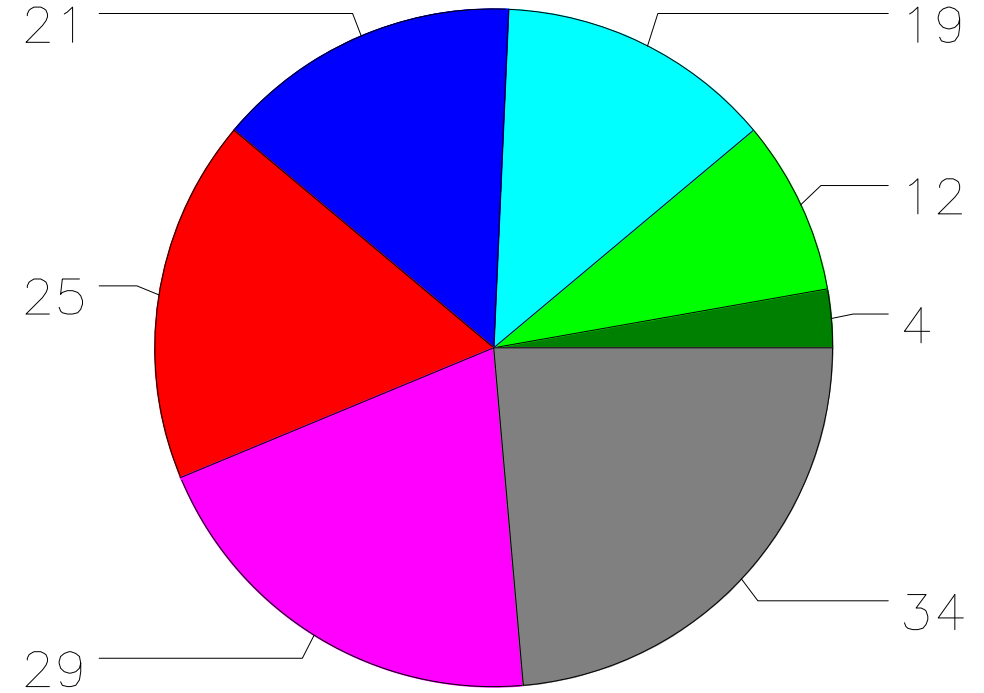


Number of buildings (of reports resp.) & detected primary damage

buildings, total 92



primary damage, total 144



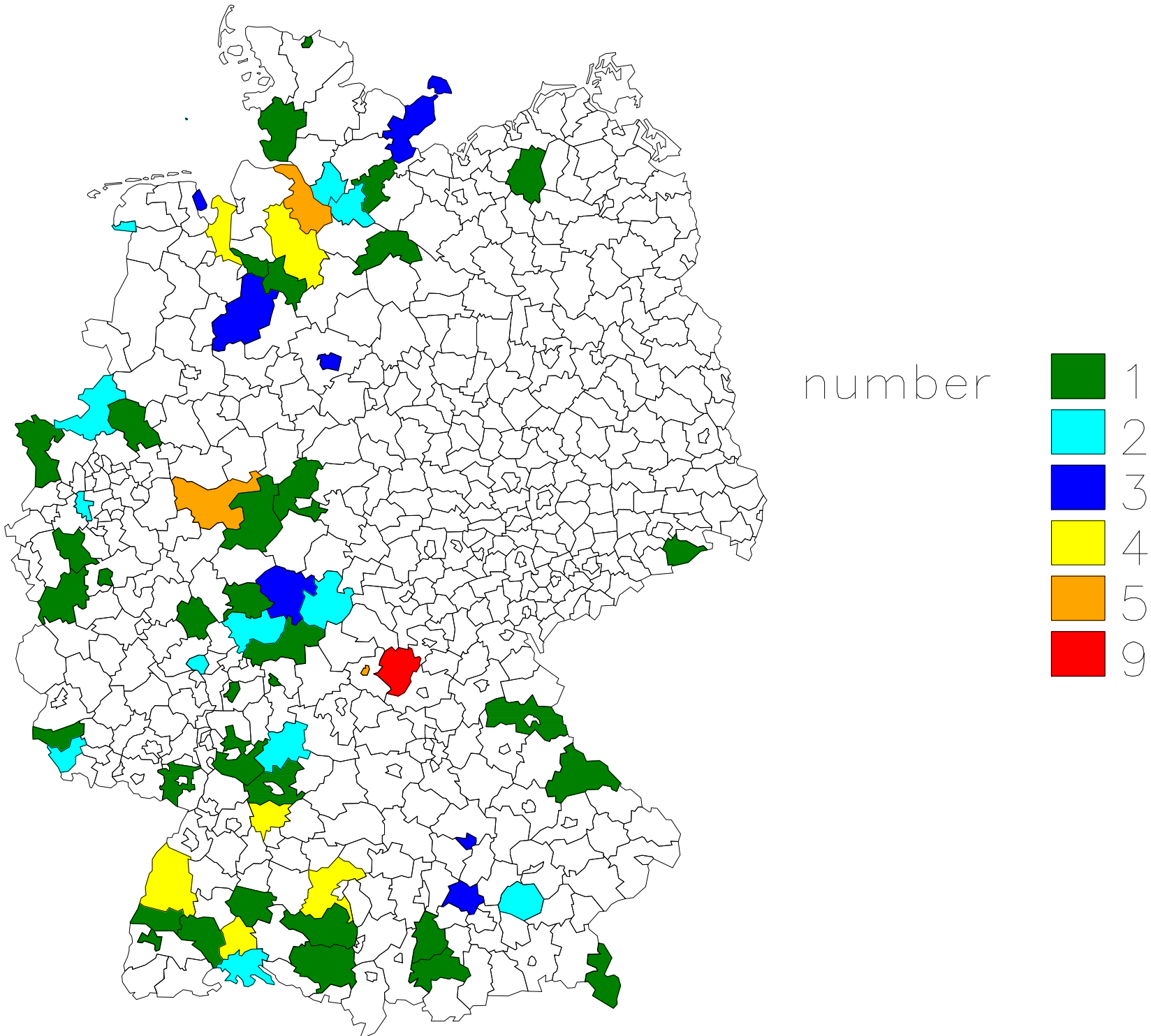
expert A
expert E

expert B
expert F

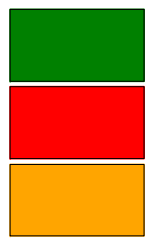
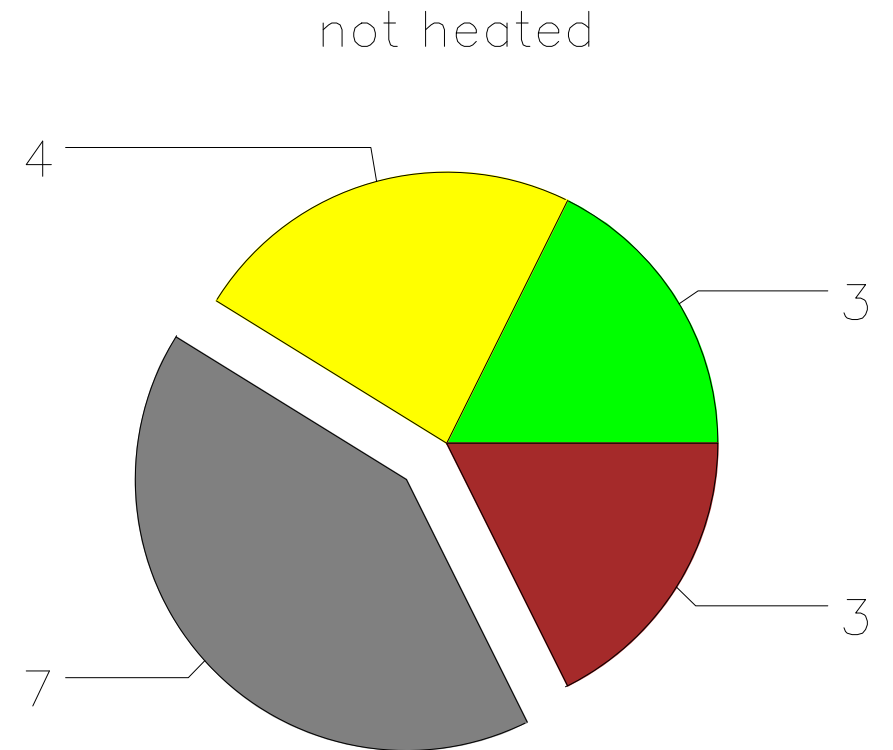
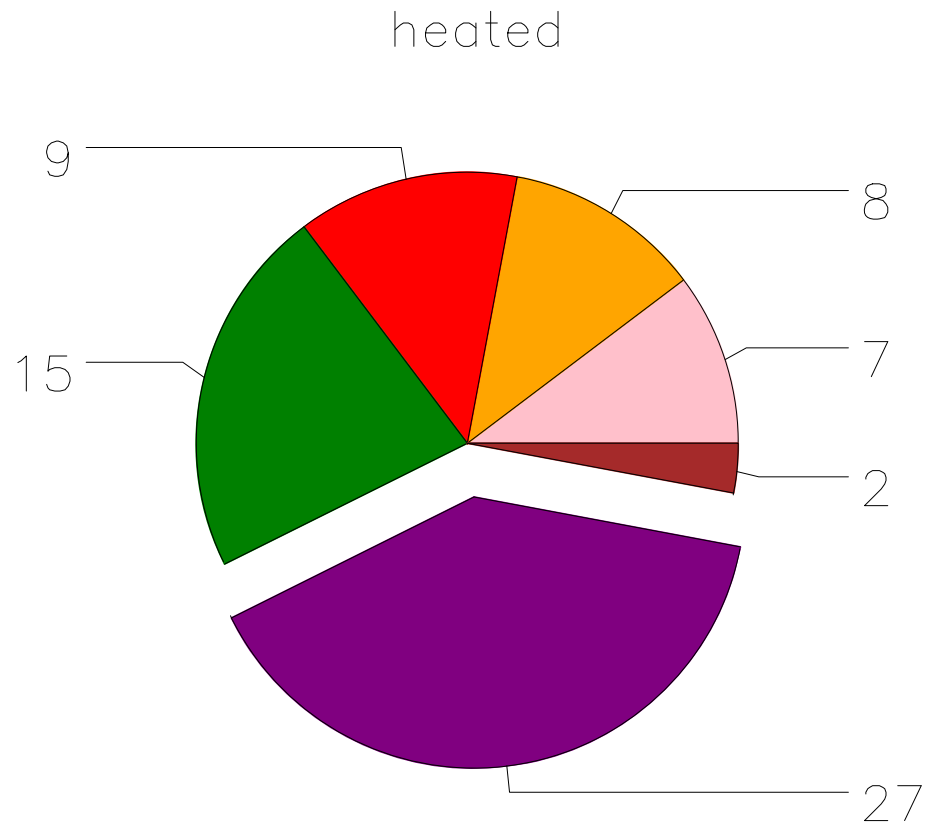
expert C
other

expert D

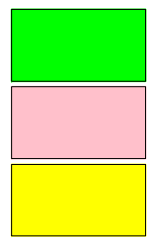
Number of primary damage related to districts



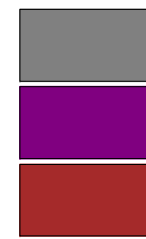
Use of building grouped according to heated and not heated constructions



assembly room
production
swimming



cattle shed
sales area
warehouse

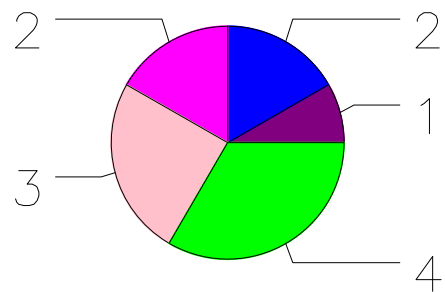


ice sports
sports
others

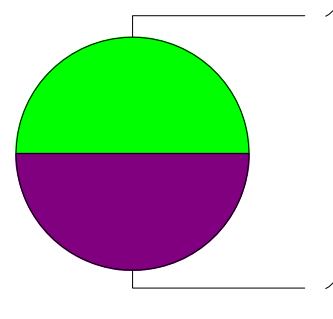


Bearing systems grouped according to components

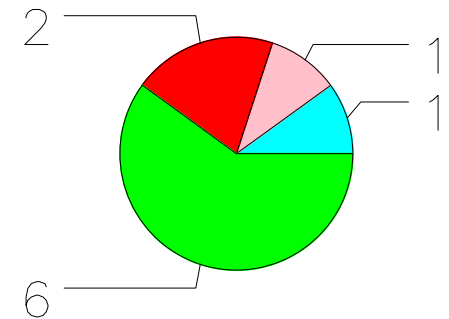
compr. member with flex.



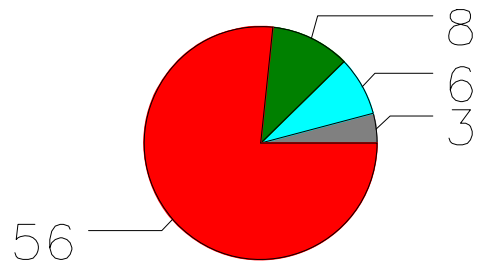
compression member



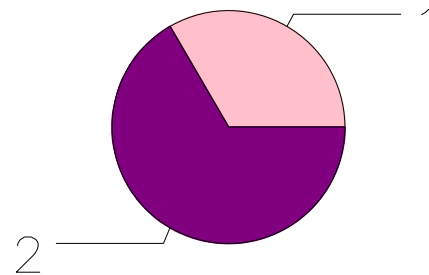
flex. member with compr.



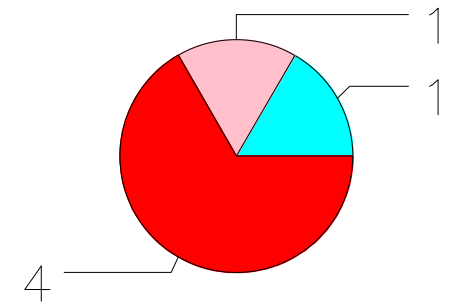
flexural member



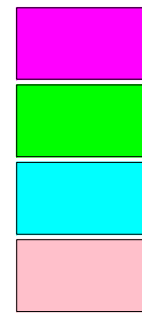
tension member



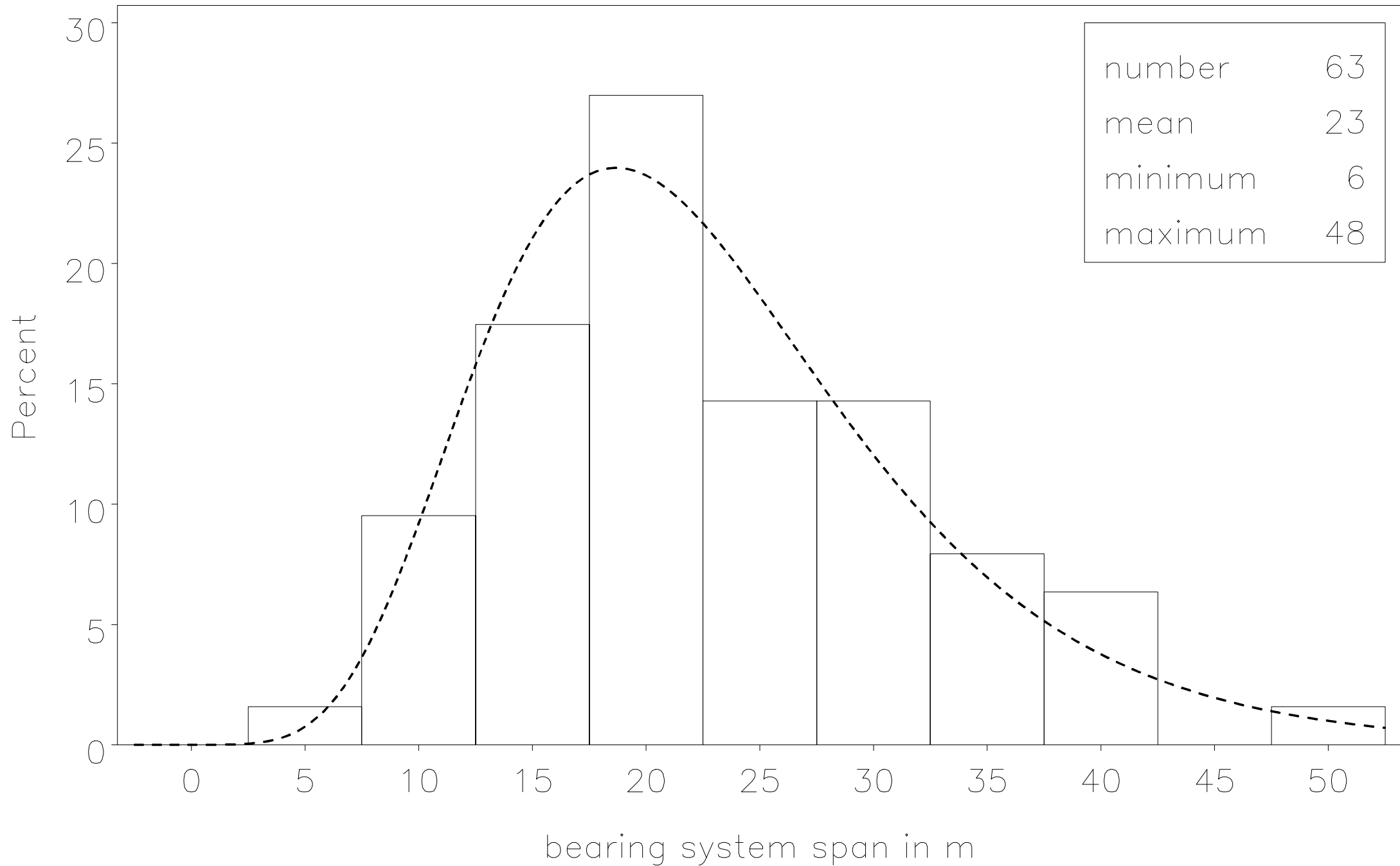
truss



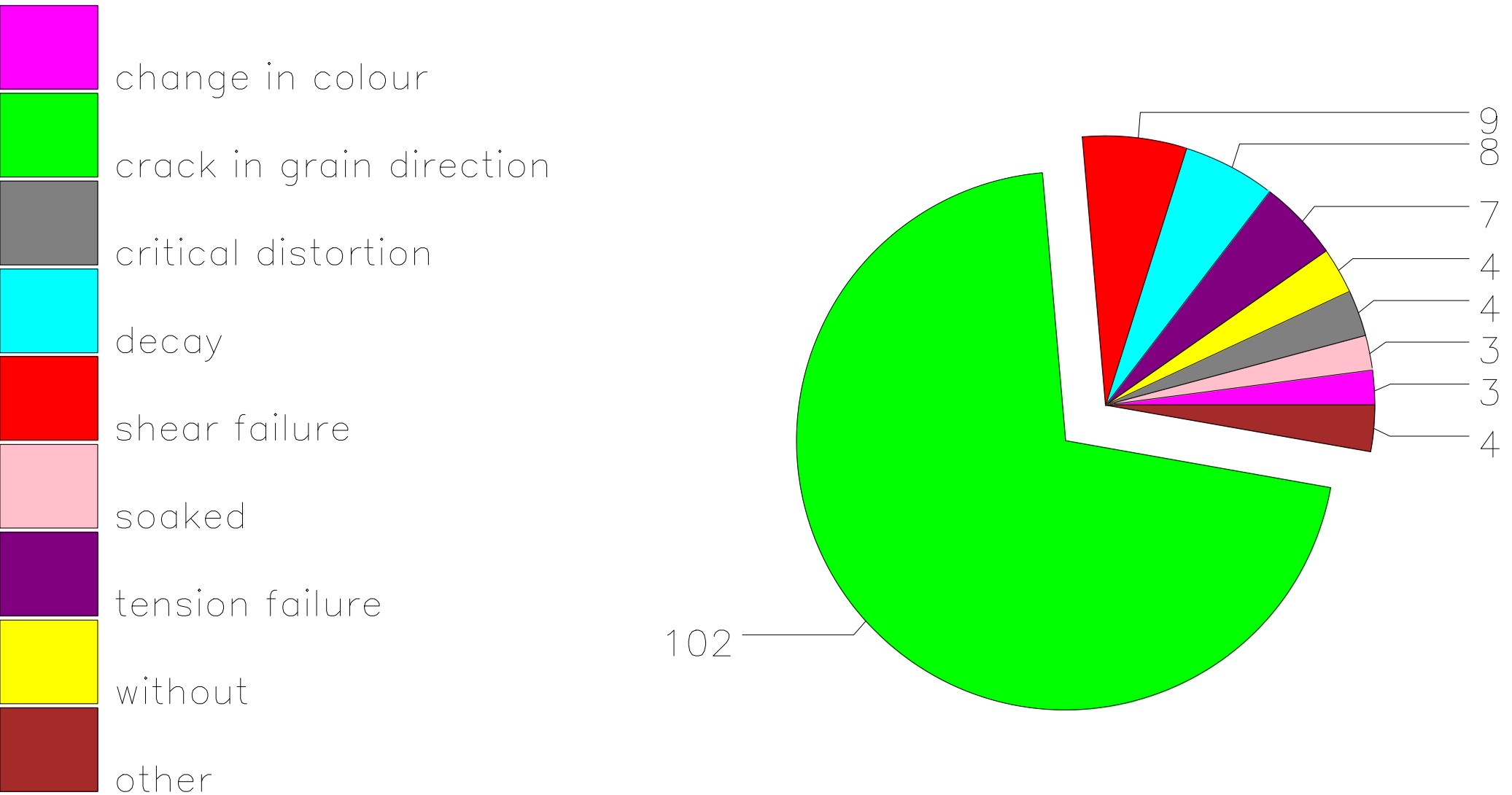
arc
continuously sup. beam
grating
simple supported beam
truss



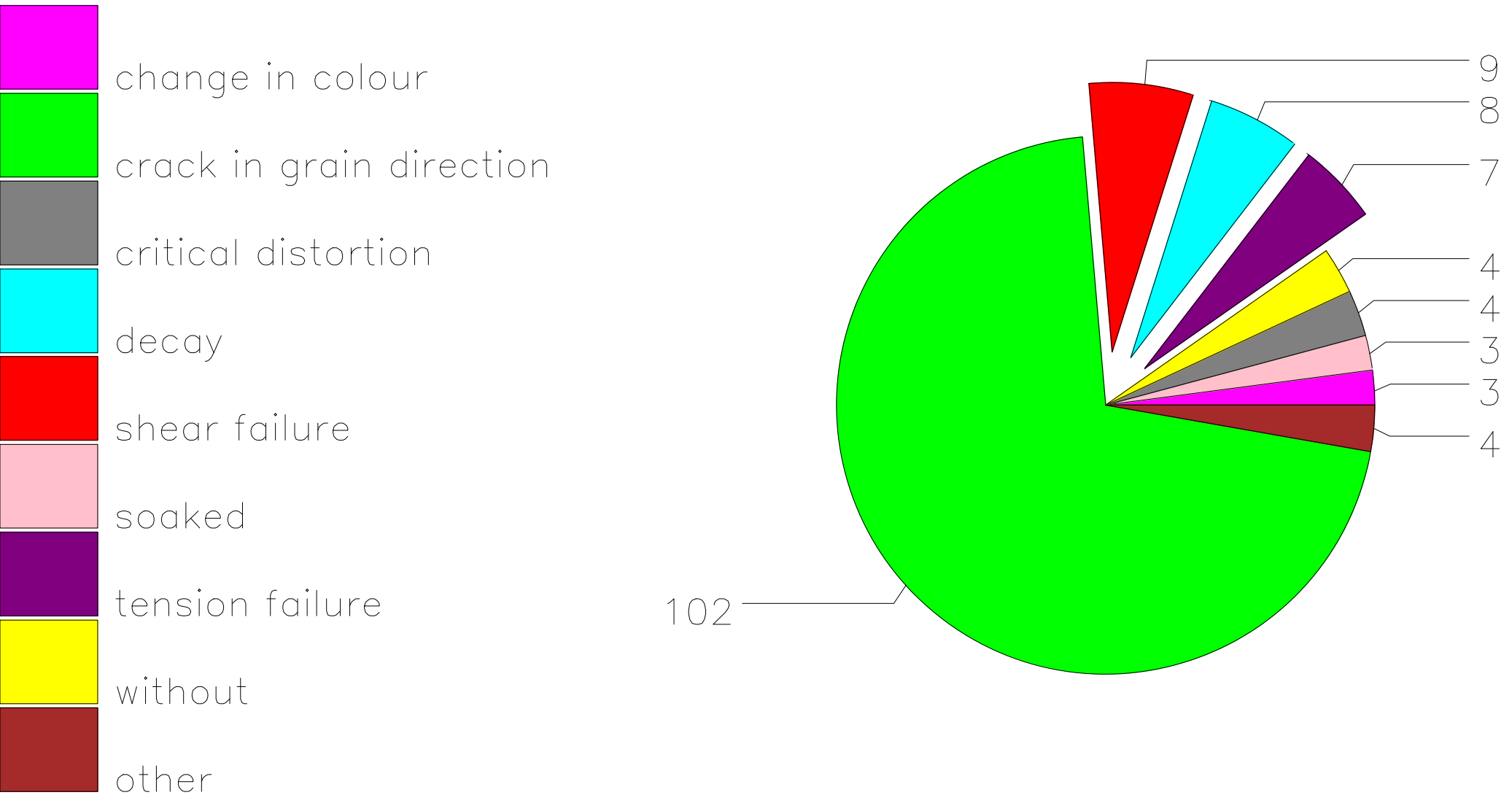
cantilever
frame
no statement
structure with hinges



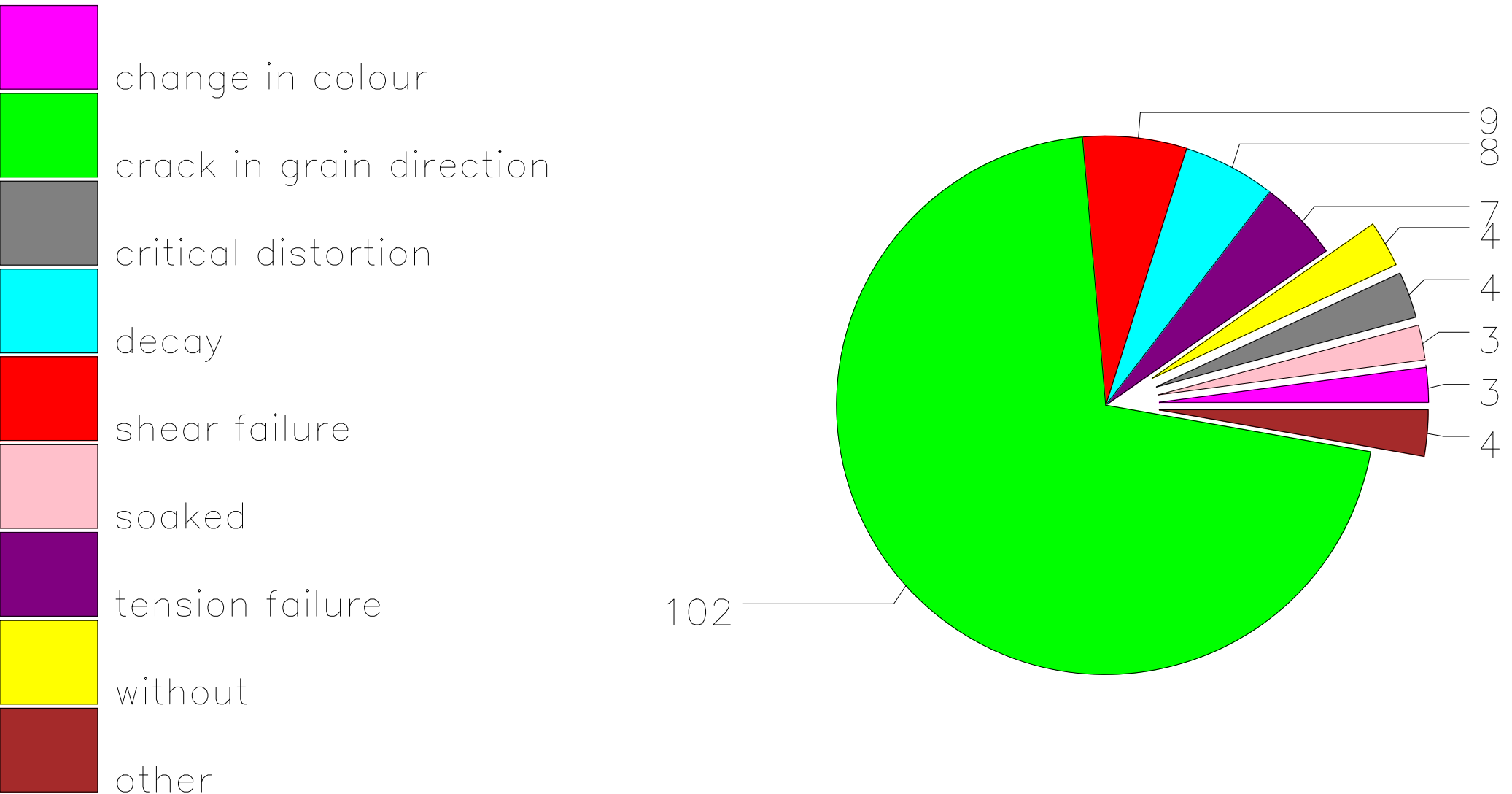
Primary damage distribution, total 144



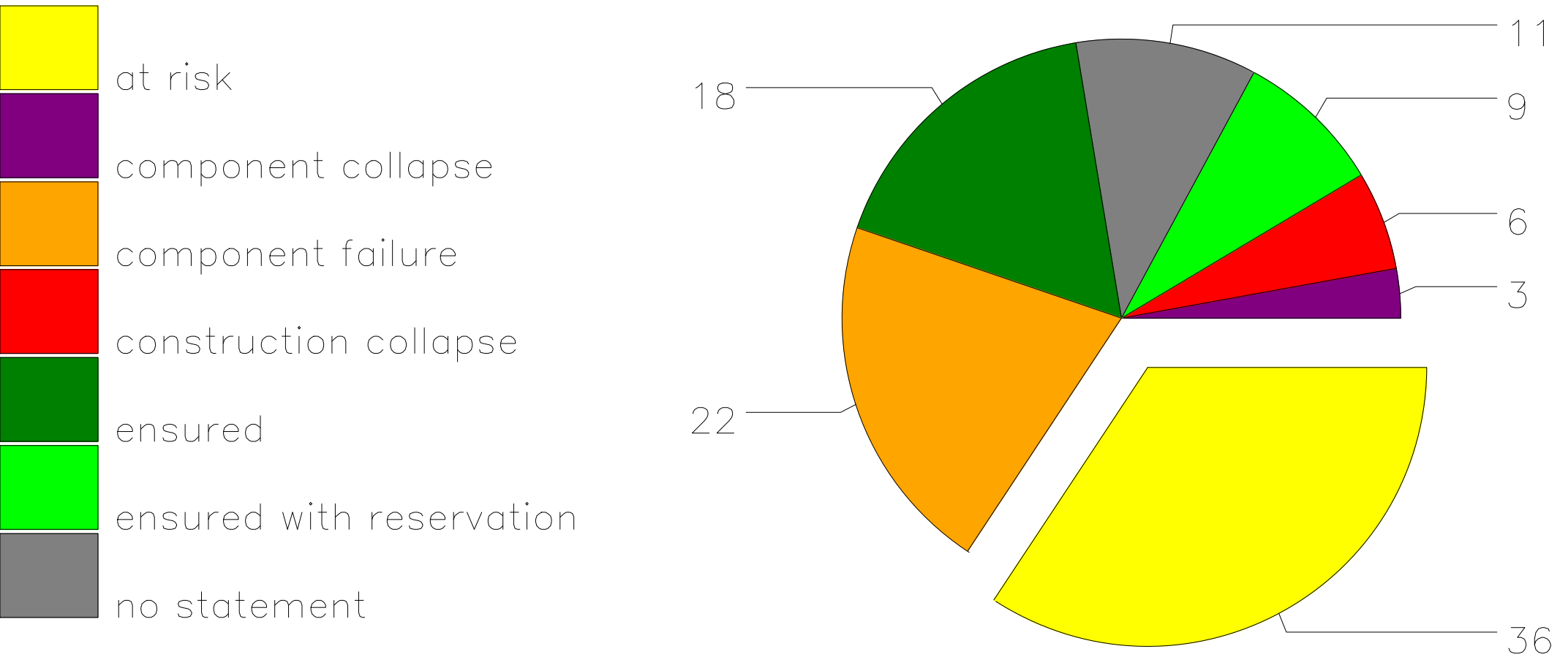
Primary damage distribution, total 144



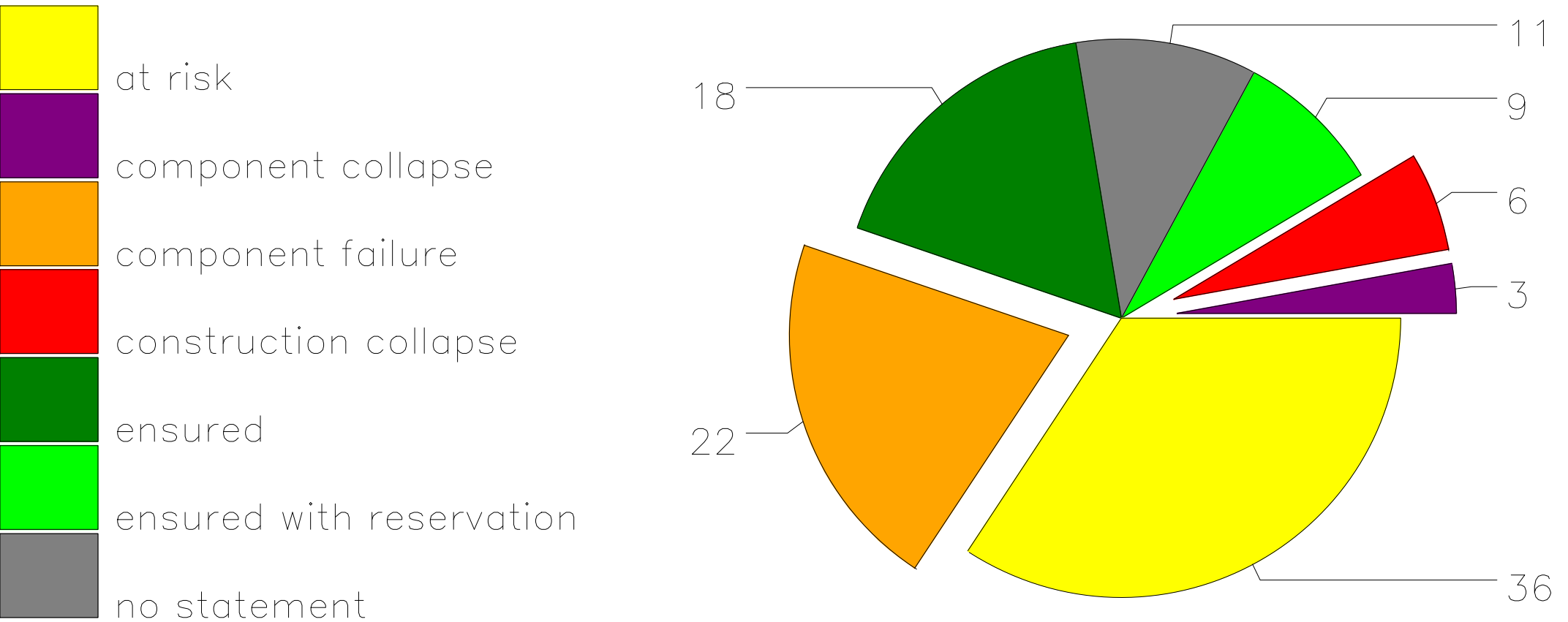
Primary damage distribution, total 144



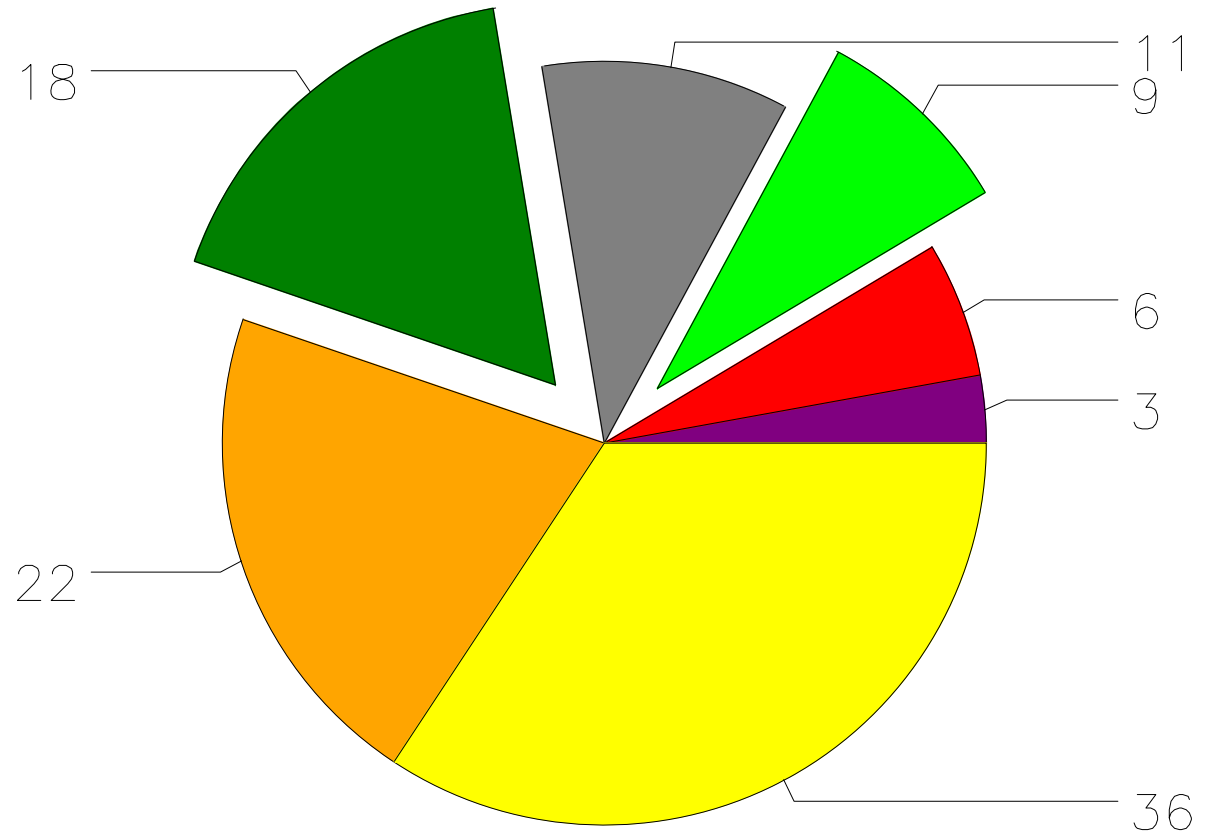
Distribution of stability assessments



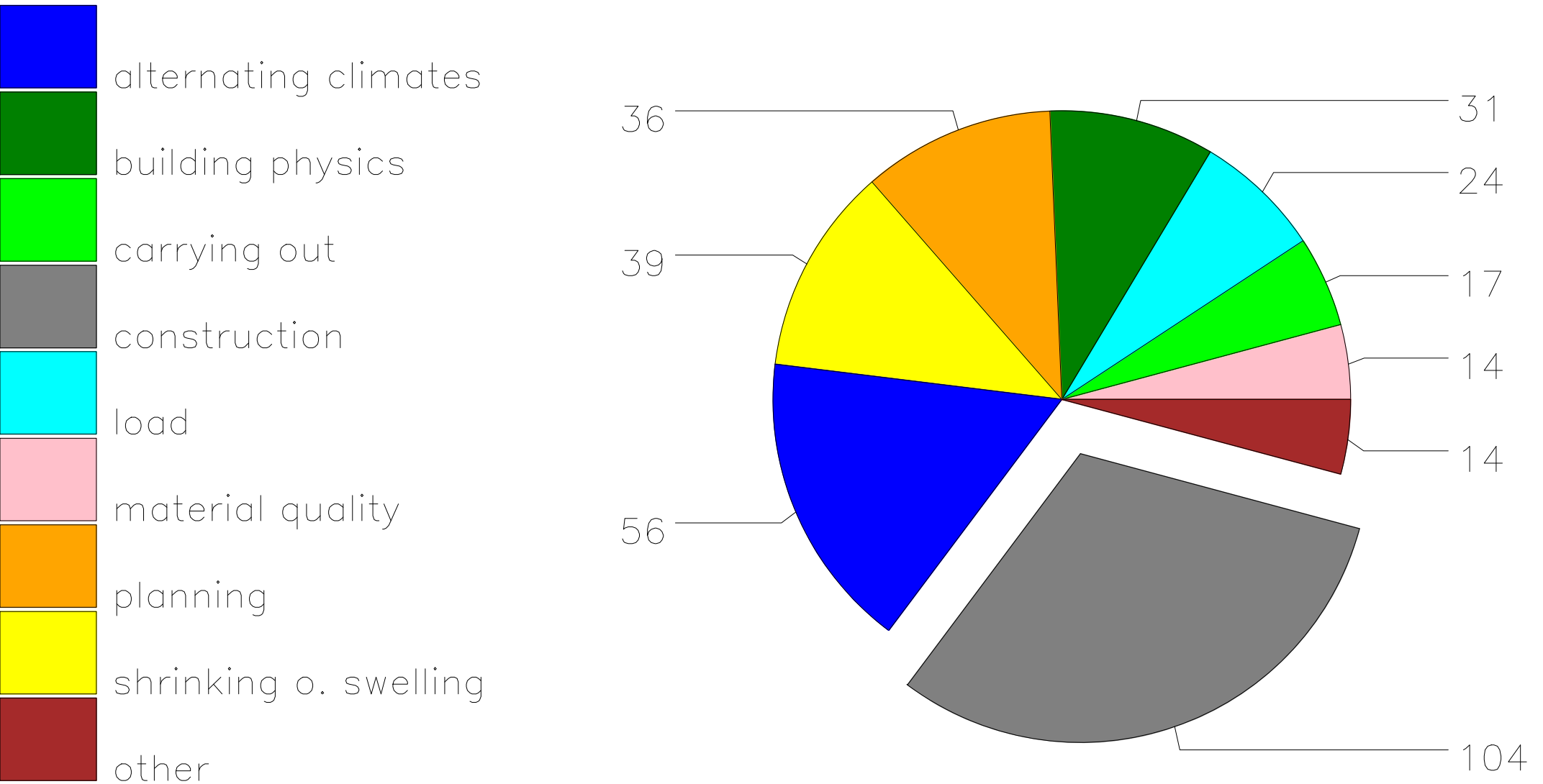
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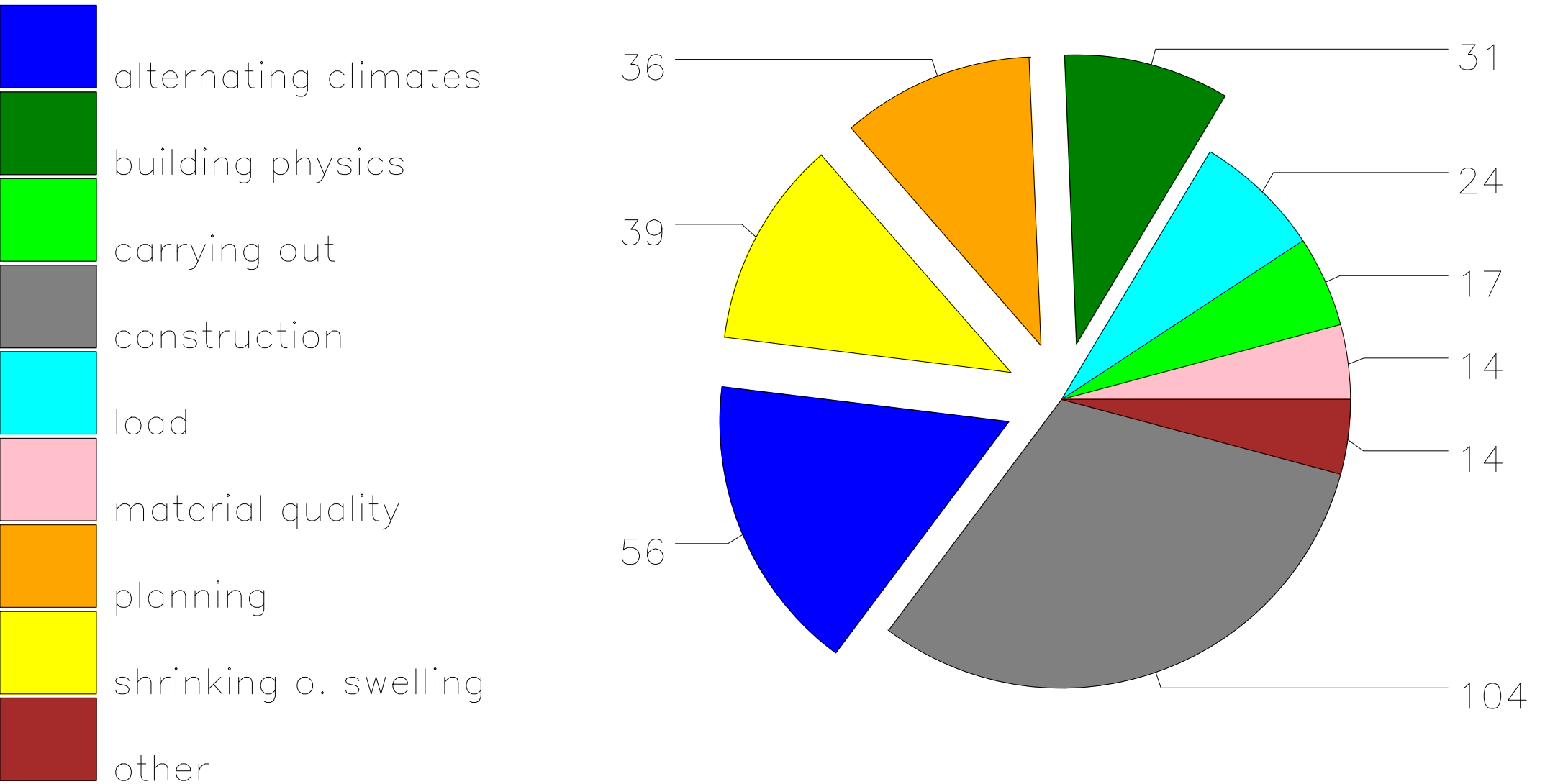
Distribution of stability assessments



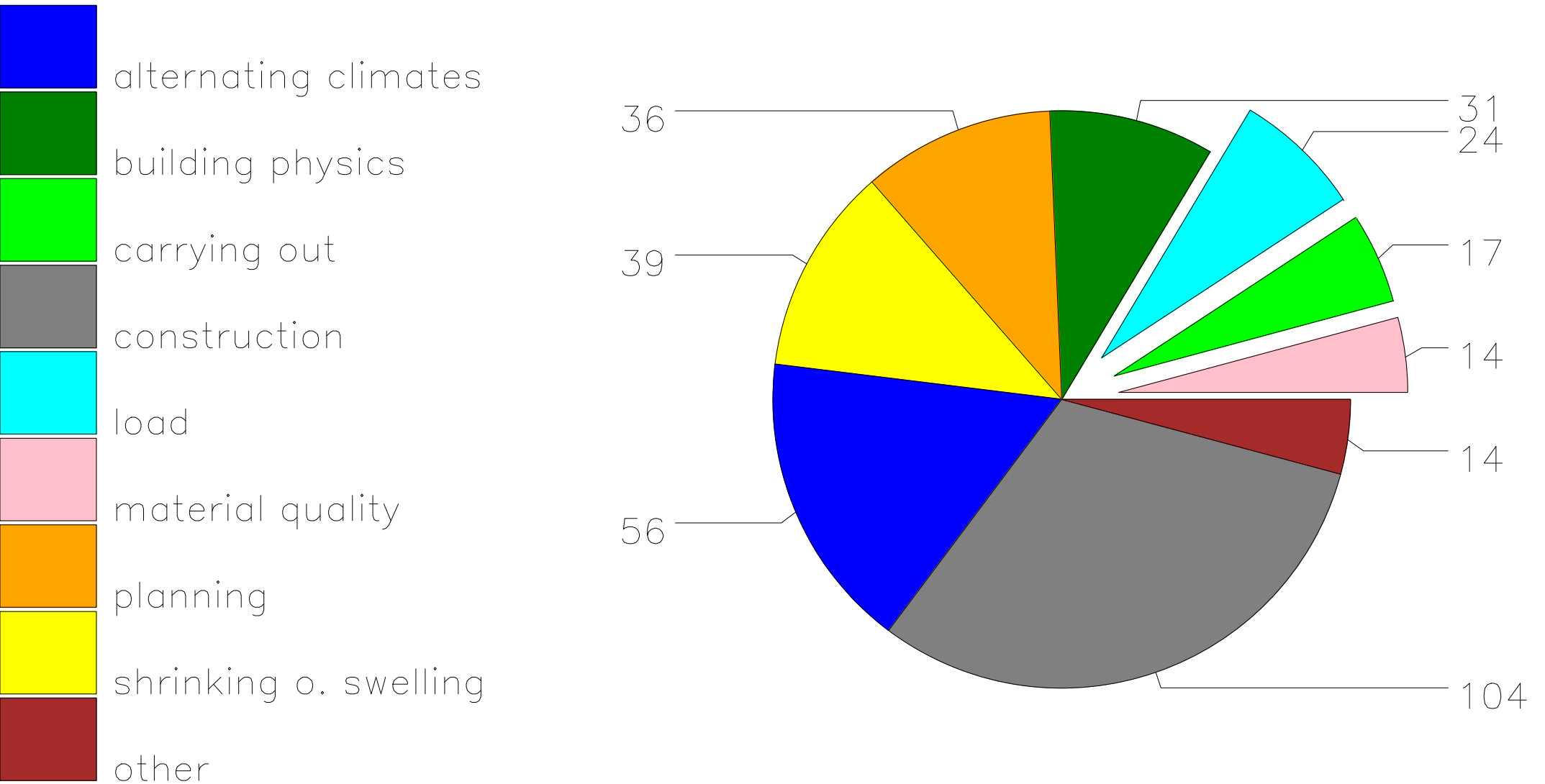
Distribution of causes of the fault, total 335 relations



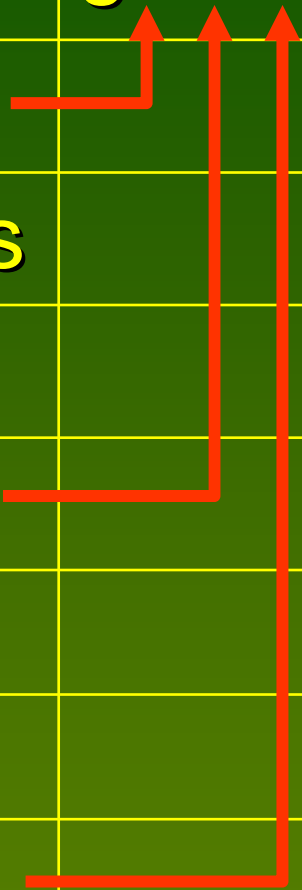
Distribution of causes of the fault, total 335 relations



Distribution of causes of the fault, total 335 relations



frequency	crack in grain dir.	shear failure	tension failure	other	total
alt. climates	53	3	0	0	56
build. physics	19	2	1	9	31
carrying out	7	0	5	5	17
construction	86	6	1	11	104
load	13	6	4	1	24
planning	25	4	6	1	36
shrink. swell.	34	4	0	1	39
other	14	2	4	8	28
total	251	27	21	36	335



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Thank you for your attention

