YMPÄRISTÖMINISTERIÖ
MILJÖMINISTERIET
MINISTRY OF THE ENVIRONMENT

Structural Safety, Experiences from Finland

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Content of presentation

- What kind of problems have come up
- What have we done
- Some remarks

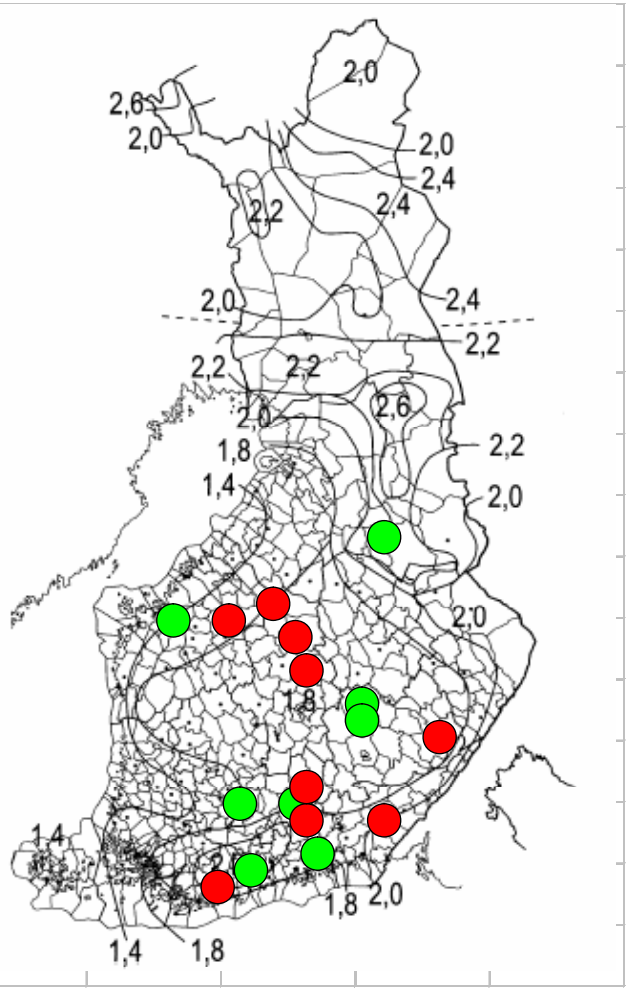
What is worrying us in Finland?

- We are used to have high level of structural safety despite there have been some accidents during paste decades –but very few casualties
- Year 2003 happened four accidents classified as incidents of major accidents. Potential casualties were up to hundreds of people.
- And there have now been more accidents every year. Especially spring 2006 happened 9 smaller accidents
- One incident of major accident happened spring 2010

The accidents have their technical reasons but no clear common factor –snow only has brought up the mistakes

Examples of accidents (2003-2006)

17.1.03	Roof Collapse, multi-purpose hall
1.2.03	Roof Collapse, fair center
25.8.03	Intermediate floor collapse, service stat
4.9.03	Inner ceiling collapse, swimming hall
1.2.04	Roof collapse, slalom centre
18.3.05	Threat of roof collapse, shopping centr
27.4.05	Inner ceiling collapse, supermarket
31.3.06	Threat of roof collapse, shopping centr
2.4.06	Roof Collapse, barn
3.4.06	Crack of glulam beam, school
5.4.06	Threat of facade collapse, supermarket
7.4.06	Crack of glulam beam, supermarket
8.4.06	Roof Collapse, supermarket
8.4.06	Threat of roof collapse, sporthall
8.4.06	Roof Collapse, manege
16.4.06	Roof Collapse, storage



What kind of accidents

2000 m^2 roof collapse of fair centre in Jyväskylä 2003

What kind of accidents

Roof collapse of fair centre in Jyväskylä 2003

- trusses made of laminated timber, span lenght 55 meters
- strength of the biggest joints featured ~50% of the planned rates
- roof truss pair having first collapsed, only had 7 dowels of 33
- major dowel joints yielded in a cleavage fracture, that is, the joint section had torn off the timber along the outer rows of the dowel group.
- European planning instructions failed to consider such a type of breaking

What kind of accidents

Roof collapse of fair centre in Jyväskylä 2003

- Finland informed comission and TC250 June 2003 with detailed technical report
- CEN/TC250 gave letter of warning concerning application on ENV 1995-1-1 (block shear failure) November 2005 (7232:CEN/TC 250)
- Defect concerning the use of ENV version of EC5 was remedied by giving a national decree (of NAD)
- Beside the fair centre in Jyväskylä there was an another remarkable large multi-purpose hall in Joensuu, which structures were strengtened due to the information of block shear failure possibility

What kind of accidents

Collapse of swimming hall inner roof structure in Kuopio 2003

What kind of accidents

Collapse of swimming hall inner roof structure 2003

- entire ceiling of the main pool 256 m² was dropped
- collapse was caused by a breaking of the suspension wires made of stainless steel, as a result of stress corrosion
- Builders had no knowledge of SFS-ENV 1993-1-4 + NAD and they were hence unable to use it in the selection of an appropriate steel quality for indoor swimming-pool and spa conditions.

What kind of accidents

Collapse of swimming hall inner roof structure 2003

- Ministry informed by a letter the building supervision authorities in communities of the spa conditions and of the use of stainless steel in those conditions
- Also the letter gave warning of the risks when the ceiling has been built as entirely integral without any expansion joints or special joints that would prevent a progression of the collapse

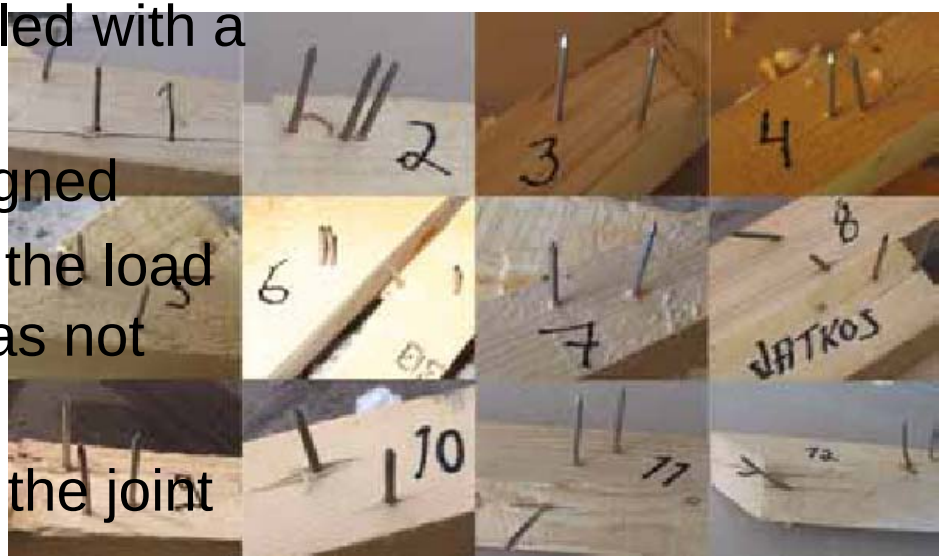
What kind of accidents

Collapse of super-market inner roof structure in Sysmä 2005

What kind of accidents

Collapse of super-market inner roof structure 2005

- one part of ceiling 400 m² was dropped
- cause was that the nail joints to the roof trusses were not strong enough
- joints had mostly two nails nailed with a compressed air nail gun
- nail joint details were not designed
- loads were not evaluated and the load capacity of this type of joint was not ensured.
- drawings did not indicate how the joint should be made.



What kind of accidents

Collapse of super-market inner roof structure 2005

- Common structure and common situation concerning design and construction
- Ministry informed by a letter the building supervision authorities of the case and of the withdrawal strenght of axially loaded nails also national standard body
- It was observed by a research, that when the connection dries after nailing, the withdrawal strength decreases considerably in Finnish climate conditions
- withdrawal strength of plain shank nails was only 43 % of the strength based on EN 1382 of connections
- The matter was included to CEN/TC250 letter of warning

What kind of accidents

Collapse of super-market roof structure in Haapajärvi 2006

- Entire roof structure 600 m² was collapsed
- Case is under research
- Supporting of wooden trussels in focus (bracing, buckling)

What kind of accidents

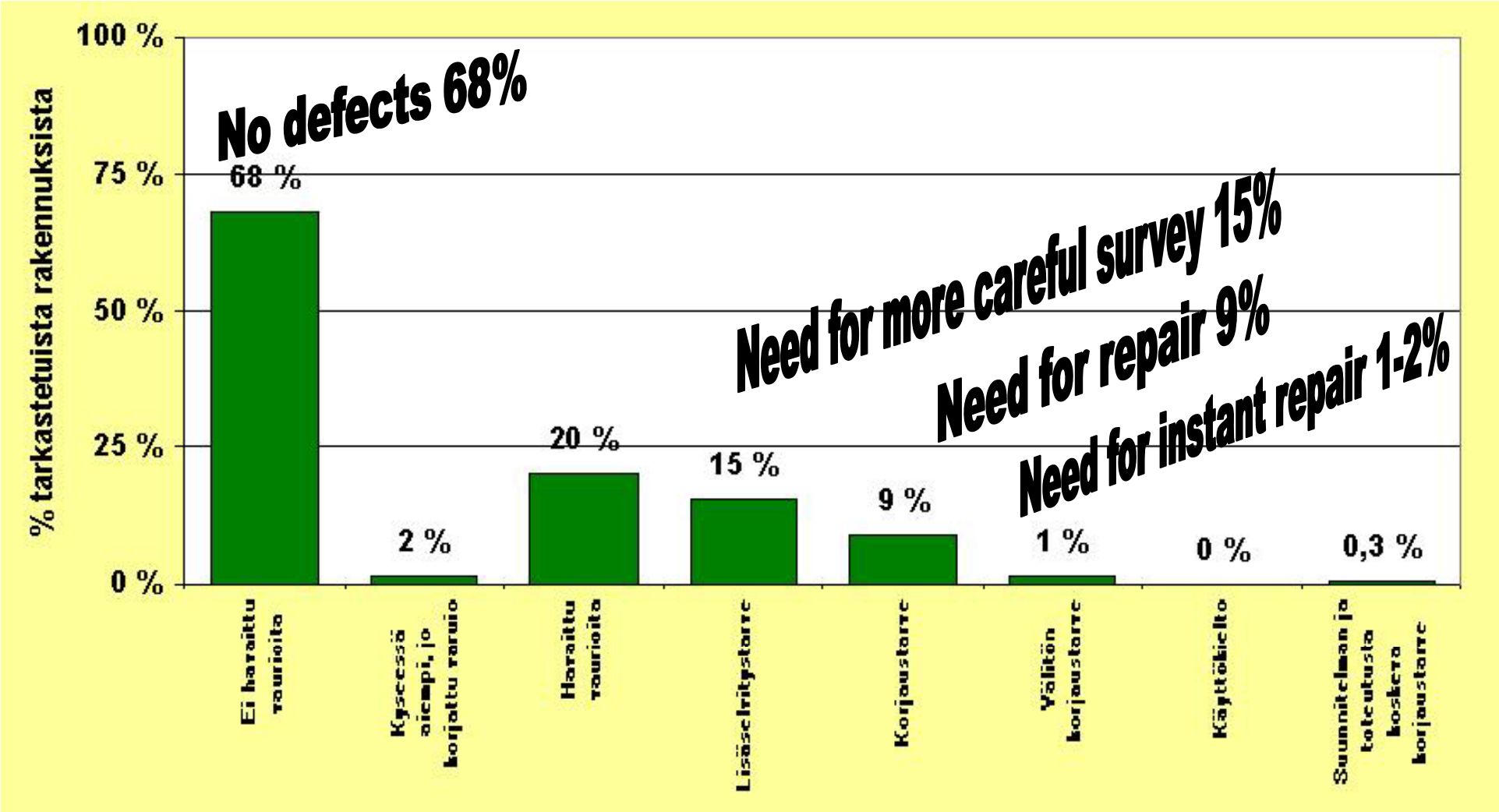
Several problems and collapses with farming buildings

What have we done?

Co-operation with construction and real estate sector

- Based on the nature of collapses year 2003 a presumption was made that best results can achieved with co-operation with the sector rather than tightening the quite new (2000) legislation which have plenty of tools to improve structural safety
- Minister of the Environment invited the main parties of interest in the sector for a meeting to discuss of the situation November 2003
- Close co-operation since December 2003->
- Sector and communities arranged a visual checking for appr. 7000 building during spring 2004

Results of the checking 2004



What have we done?

Co-operation Accidents Investigation Board Finland

- In Finland there is under the Ministry of the Justice an Accidents Investigation Board which enables independent and carefully detailed investigation of major accidents and incidences of major accidents
- The Board also gives recommendations based on their research
- This is the case also concerning the roof collapses
- Ministry of the Environment is carrying out all these recommendations through its guidance

- See www-pages Accidents Investigation Board Finland: www.onnettomuustutkinta.fi

What have we done?

Co-operation Accidents Investigation Board Finland

- Examples of the Board recommendations:
- organizations active in the building business should develop such methods that ensure an adequate cooperation among the different parties engaged in a building project
- such methods ought to be designed and developed for the construction business that enable an identification of any safety critical details in a building project
- To secure an appropriate quality standard of European planning and design instructions, it is recommended that a corresponding drawing up and maintenance system be generated so as to permit a rapid response to any safety critical error or shortcoming

What have we done?

Revised building code concerning supervision of construction work

- Based on the recommendations of Accident Investigation Board and co-operation with building sector risk assessment procedure and actions based on the assessment were included in the technical regulations and guidelines in Finnish building code
- The revised building code with external inspection procedure was taken into action 2006

What have we done?

chart of action

construction defect bank (FISE)
- defects and right solutions
- see www.fise.fi

Farming buildings with wide span
- guidelines of risks and structures
- determination of defects

Sport Halls with wide span
- welding guidelines
- guidelines for use of structural software
- EC5 stiffening guidelines
- inspection guidelines for wood and steel structures
- estimation guidelines risks due to cracking of glulam barriers
- risk management guidelines

Snow load warning system www.syke.fi

Cowork of Building Sector
- since 2003-
- inspection of building 2004
- declarations 2003, 2004 ja 2006
- special procedure to ensure structural safety: Publication RIL 241-2007 (see www.ril.fi)

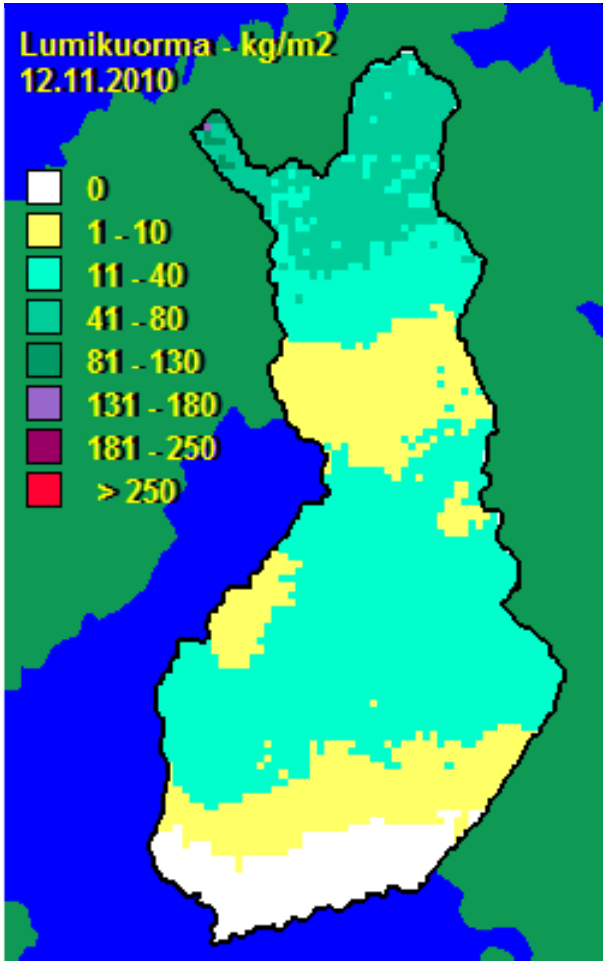
Changes in Building Codes
- RakMK A1 (2006)
- B-part recast (2007-2011)
- EC part I (2007)

Ministry letters and studies
- researchs and reports, see www.ymparisto.fi
- letters to building sector and municipal building authorities

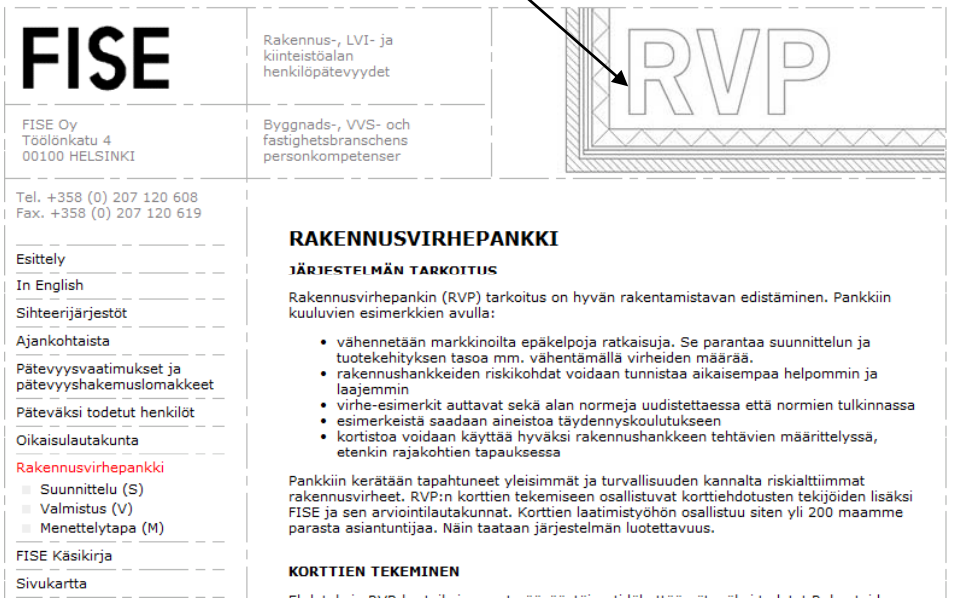
Standardisation
- Letters to comission ja TC250
- warning letter of TC 250:n
- letter conserning wooden trussels with nail plates

What have we done?

snow load, bank of defects



Construction Defect Bank (www.fise.fi)



FISE

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RVP

Esittely
In English
Sihteerijärjestöt
Ajankohtaista
Pätevyysvaatimukset ja pätevyyshakemuslomakkeet
Päteväksi todetut henkilöt
Oikaisulautakunta
Rakennusvirhepankki
- Suunnittelu (S)
- Valmistus (V)
- Menettelytapa (M)

FISE Käsikirja
Sivukartta

RAKENNUSVIRHEPANKKI

JÄRJESTELMÄN TARKOITUS

Rakennusvirhepankin (RVP) tarkoitus on hyvän rakentamistavan edistäminen. Pankkiin kuuluvien esimerkkien avulla:

- vähennetään markkinoilta epäkelpoja ratkaisuja. Se parantaa suunnittelun ja tuotekehityksen tasoa mm. vähentämällä virheiden määrää.
- rakennushankkeiden riskikohdat voidaan tunnistaa aikaisempaa helpommin ja laajemmin
- virhe-esimerkit auttavat sekä alan normeja uudistettaessa että normien tulkinnassa
- esimerkeistä saadaan aineistoa täydennyskoulutukseen
- kortistoa voidaan käyttää hyväksi rakennushankkeen tehtävien määrittelyssä, etenkin rajakohtien tapauksessa

Pankkiin kerätään tapahtuneet yleisimmät ja turvallisuuden kannalta riskialttiimmat rakennusvirheet. RVP:n korttien tekemiseen osallistuvat korttiehdotusten tekijöiden lisäksi FISE ja sen arviointilautakunnat. Korttien laatimistyöhön osallistuu siten yli 200 maamme parasta asiantuntijaa. Näin taataan järjestelmän luotettavuus.

KORTTIEN TEKEMINEN

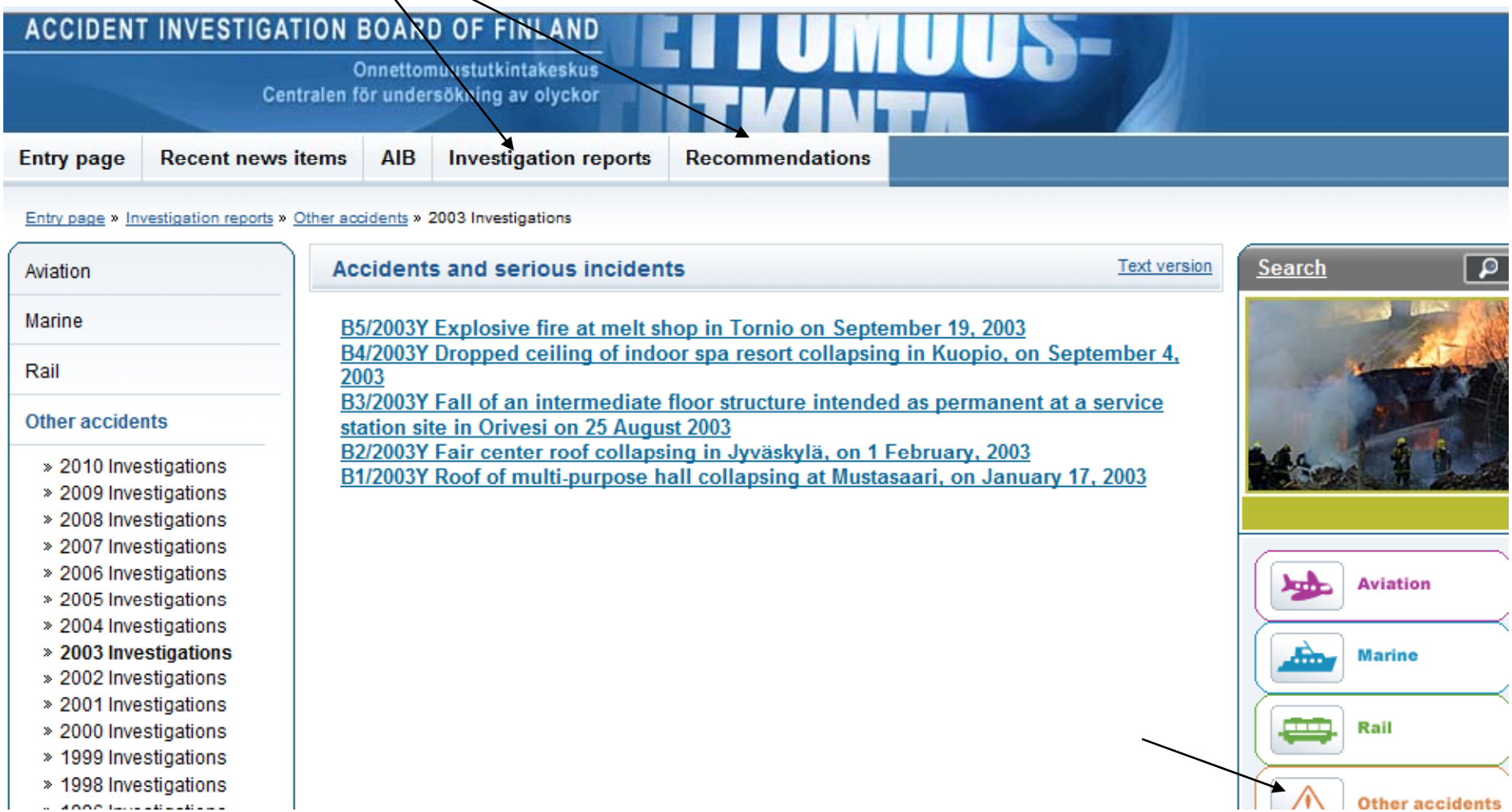
Snow Load warning system (maps and local warnings) by Finland's environmental administration

What have we done?

accident investigation board of Finland

What have we done?

accident investigation board of Finland (by ministry of justice)



Remarks

Maintenance of Eurocodes

- The maintenance system of Eurocodes is important both on the national level and the european level in the mean of structural safety. Information of possible risks and possible errors should be available without delay.
- The block shear failure was taken into the account in EN1995, but It took 2,5 years from the detailed information given to TC250 and to the comission to get a letter of warning for european countries
- ENV version was easy to repair fast by national legislation –should such a possility be presented also now in the cases of clear safety risk as the EC will be taken into use, like in Finland, during 2007-2010?

Remarks

CE marking

- in Finland all construction products that have been labelled with the CE marking and provide the required performance are deemed to meet the technical requirements of the product's designated use
- products intended for use as permanent elements in a building shall be such that the building, when properly designed and constructed, meets the essential requirements set for construction during its economic service life if maintained normally
- therefore CE labelled structural units, based on either on testing or calculating, has to be reliable in the mean of structural safety and all errors should be able to corrected without any delay in revised CPD

Remarks

External Inspection

- Finnish Land Use and Building includes several tools to improve structural safety. The external inspection (151§) has now found useful tool in demanding constructions as a tool of risk management.
- Building supervision authority may -while processing a permit application or during construction work- require that the permit applicant provide an expert opinion on whether the planned approach or the construction work meets the demands prescribed for it
- This external inspection, like prüfung in Germany, has been during 4 years found to be an effective tool to achieve necessary structural safety both by the Finnish real estate sector and construction industry and the building authorities

Accidents and Safety in Construction