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Gjennomgang av SINTEF Vurderingsrapport nr. 103202.46 "Assessment of Isover Fire Protect 150 mineral wool insulation for fireprotection of structural corrugated steel roofs: Design Tools for Fire Protection"

På forsiden til SINTEF Vurderingsrapport nr. 103202.46 står det angitt *Date for review 2007-10-06.*

Vi har ette henvendelse fra oppdragsgiver gått igjennom Vurderingsrapporten og sammenliknet denne med hvordan vi i dag gjør denne form for vurderinger. Grunnlag og prosedyrer er uforandret, og vi finner ingen grunn til å endre på dimensjoneringstabellene gitt i rapporten. SINTEF NBL mener derfor at dokumentet fortsatt er gyldig for bruk som grunnlagsdokumentasjon i et byggeprosjekt. Det er imidlertid ansvarlig brannrådgiver som må gå god for at det er samsvar mellom denne vurderingens forutsetninger og prosjektering og utførelse i det enkelte byggeprosjektet.

Vår SINTEF Produktdokumentasjon 010-0202 omfatter ikke isolering av korrugerte stålplatetak med Isover Fire Protect. Denne form for brannisolering er så avhengig av fagmessig riktig utførelse at dette må ivaretas i hvert enkelt byggeprosjekt. Dagens praksis er derfor at isolerte stålplatetak ikke inkluderes i Produktdokumentasjonen.

I dagens vurderingsrapporterer skriver vi inn følgende tekst under Remarks:

Please note this is not a general approval, but the document can be used as documentation in an individual building project.

This assessment is valid for load bearing corrugated steel roofing with thermal insulation on top and ..... on the underside. Important precautions are depth/width-ratio of corrugated steel roof, type of thermal roof insulation and the attachment technique used for the ..... boards. These conditions must be compared and evaluated with the actual solution in the individual building project by the responsible fire engineer. This assessment will therefore not be included in the present SINTEF Product Documentation No. 010-XXX issued to XXXX on the product XXX.

The validity of the Design Tools in this assessment report requires that the depth (height) of the corrugation is at least the width of the base of the corrugation. It is also a requirement that the

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thermal insulation on top of the steel roof is uncombustible.

SINTEF NBL is not responsible for the use of this assessment report in the individual building project. The responsible fire engineer for the actual building project must verify that all assumptions made in this assessment are fulfilled in the actual project.

Vi forutsetter derfor at teksten over implementeres ved anvendelse av vurderingsrapporten i norske byggeprosjekter.

Med vennlig hilsen
for SINTEF NBL as

Ulf Danielsen

SINTEF

ASSESSMENT REPORT

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TITLE

Assessment of Isover Fire Protect 150 mineral wool insulation for fireprotection of structural corrugated steel roofs: Design Tools for Fire Protection

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ELEKTRONIC FILE CODE		
I:\PRO\103202\46\103202_46-AssessmentReport-steel_roofing.doc		
REPORT DATE	DATE FOR REVIEW	TOTAL NO. OF PAGES
2005-10-06	2007-10-06	19

SUBJECT FOR EVALUATION

SINTEF NBL is asked to prepare a simple design tool for fire protection of structural corrugated steel roofs with Isover Fire Protect 150 mineral wool insulation. The assessment is valid for loadbearing corrugated steel roofing with thermal insulation on top and Isover Fire Protect 150 on the underside.

Basis for the analysis is Assessment Report no. 103202.08 from SINTEF NBL presenting design tools for fire protection of steel structures derived using the method described in NT Fire 021 "Insulation of Steel Structures: Fire Protection."

MAIN CONCLUSION(S)

A simple Design Tool for prediction of proper thickness of Isover Fire Protect 150 below corrugated steel roof panels with thermal insulation on the top **for 30, 60 and 90 minutes** endurance time in a Standard Fire Exposure is presented.

Based on the graphical Design Tools insulation thickness can be chosen as a function of fire endurance time, steel panel thickness and critical steel temperature ranging from 300-700 °C.

The design tools are limited to panel thickness ranging from 0,56 – 3,0 mm, and for board thicknesses ranging from 20mm to 60mm.

The way of attaching the insulation boards to the corrugated steel roof must be documented for the actual fire resistance. This is not taken into consideration in this assessment.

REFERENCES:

SINTEF NBL has previously assessed **Isover Fire Protect 150 mineral wool insulation** according to the calculation procedure described in NT Fire 021 "Insulation of Steel Structures: Fire Protection.":

- Assessment Report No. 103202.08 dated 2004-11-26 from SINTEF NBL

This report is basis for the evaluation.

REMARKS:

Please note this is not an approval, but shall be considered as an assessment for use together with the above mentioned references, when applying to the authorities for classification before date of review. After this date, we should review the assessment before use. The assessment is based on experience and the information supplied.

Any changes in the specification of the products will invalidate this assessment.

NBL recommends the assessment to be returned for review after a period of 2 years, to consider any available additional data, or changes in the fire procedures.

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Summary

SINTEF NBL is asked to prepare a simple design tool for fire protection of structural corrugated steel roof panels with **Isover Fire Protect 150** mineral wool insulation. The assessment is valid for loadbearing corrugated steel roofing with thermal insulation on top and Isover Fire Protect 150 on the underside.

Basis for the analysis is Assessment Report no. 103202.08 from SINTEF NBL presenting design tools for fire protection of steel structures derived using the method described in NT Fire 021 "Insulation of Steel Structures: Fire Protection."

The characteristic thermal conductivity for 30, 60 and 90 minutes fire endurance time derived from the NT Fire 021 analysis are used to calculate the steel temperature in the insulated corrugated steel roof panels. The same conductivities were used in Assessment Report 103202.08.

Calculations are made with thermal conductivity curves for Safety Factor X=0,0 (AVG) and X=1,0 (RES). Thermal conductivities used in this assessment are given in Appendix C.

X is a multiplication factor for addition of Standard Deviation to the conductivity function.

The multiplication factor X is set to zero (0.0) for the assessment valid for use in Sweden. (See Appendix A).

The multiplication factor X is set to 1.0 for the assessment valid for use in Norway, Denmark and Finland. (See Appendix B).

The output from the analyses is presented in Appendix A-B.

Assessment methodology

SINTEF NBL has previously assessed **Isover Fire Protect 150 mineral wool insulation** according to the calculation procedure described in NT Fire 021 "Insulation of Steel Structures: Fire Protection.":

- Assessment Report No. 1030202.08 dated 2004-11-26 from SINTEF NBL

A computer programme with the calculation procedures from NT Fire 021 is used to calculate characteristic thermal conductivity curves for the fireproofing material on each of the test specimens. A resulting thermal conductivity curve given by the average values at each temperature level + X × the Standard Deviation at the same temperature level is used when calculating the design steel temperatures for section factors of the steel sections and different board thicknesses of the fire protection material.

X is a multiplication factor, which is set to unity (1.0) for the assessment valid for use in Norway, Denmark and Finland. (See Appendix B).

The multiplication factor X is set to 0.0 for the assessment valid for use in Sweden. (See Appendix A).

The characteristic thermal conductivity for 30, 60 and 90 minutes fire endurance time derived from the NT Fire 021 analysis are used to calculate the steel temperature in the insulated corrugated steel roof panels. Calculations are made with thermal conductivity curves for Safety Factor X=0,0 and X=1,0. The same conductivities were used in Assessment Report 103202.08 (see Appendix C).

Calculations are made for 30 minutes, 60 minutes and 90 minutes fire endurance time. The results are given as design graphs and tables of calculated steel temperatures for each resistance time. See Appendix A and B.

With basis in a principle drawing of a corrugated steel roof panel (see left sketch Figure 1) with a given panel thickness t_s, thermal roof insulation on top and **Isover Fire Protect 150** below fixed to the steel roof by means of welded pins and washers, SINTEF NBL has chosen a simple calculation model in order to utilize the results from the NT Fire 021 assessment. This approach requires satisfactory retention of the insulation.

For this specific analysis the design tool in the NT Fire 021 analysis is extended to cover section factors up to 900 m^{-1} relevant for the lower plate thicknesses. The model (see right sketch in Figure 1) is based on a corrugated steel roof panel where the exposed side is insulated with fire protection and the unexposed side is modelled with adiabatic boundary conditions, i.e. no heat exchange since the upper side is thermally sealed with roof insulation.

This is not a formal approval of the fireproofing material **Isover Fire Protect 150** for use in Norway, but may be used as a basis for an application to the certifying authorities. NEMKO Certification (former The Norwegian Certification Systems - NCS) is the certifying body for this type of material in Norway.

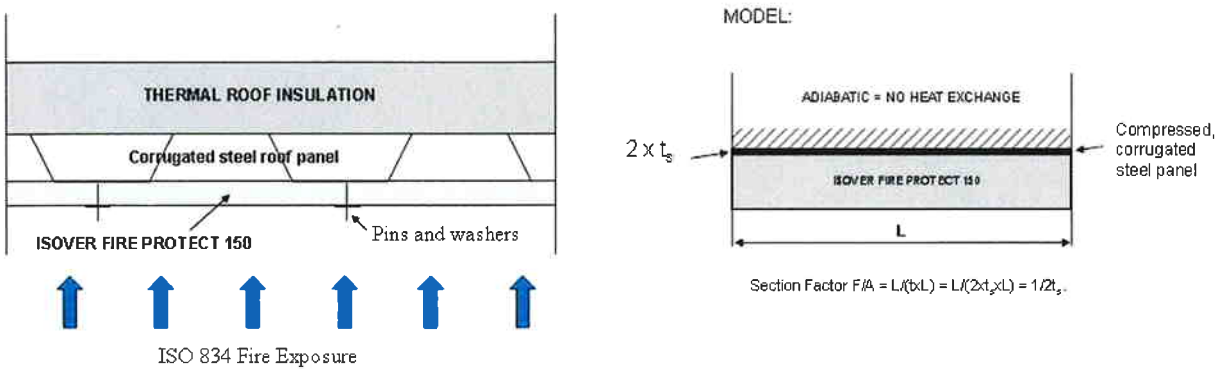


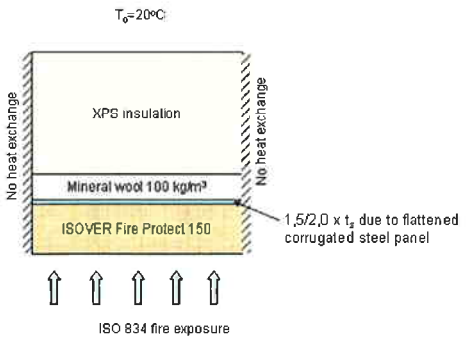
Figure 1 Principle drawing of corrugated steel roof panel (left) and the calculation model where the corrugated steel panel is compresses and seen as a flat plate with thickness 2 x t_s.

In order to verify the model approach simulations are carried out with the Finite Element program SUPER Tempcalc®.

1D simulations are carried out for a steel panel insulated on one side with ISOVER Fire Protect 150 and on the other side with 50mm mineral wool 100 kg/m^3 + 150mm XPS. Temperature dependant data are used for all materials. The fire insulation is subjected to Standard Fire exposure and the unexposed side to ambient conditions of 20°C.

Two series of calculations are carried out :

1. the corrugated steel panel is modelled as a flat plate with thickness 1,5 x t_s
2. the corrugated steel panel is modelled as a flat plate with thickness 2,0 x t_s.



The increased steel thickness shall take care of the depth of the corrugations, i.e. the steel mass is represented by a flat plate.

In the NT Fire 021 assessment presented here a flat plate approach with steel thickness 2 x t_s has been used (see Figure 1).

Comparisons of the results from the FEM analysis and the results from the NT Fire 021 assessment show that the FEM analysis predict lower steel temperatures than the NT Fire 021 approach for all combinations of steel plate thicknesses 0.6mm – 3.0mm, and thicknesses 35mm and 50mm of ISOVER Fire Protect 150 for both for the 1,5 x t_s – simulation and 2,0 x t_s – simulation.

This is a. indication that the NT Fire 021 is on the safe side. The results from the FEM simulations are presented in Appendix D.

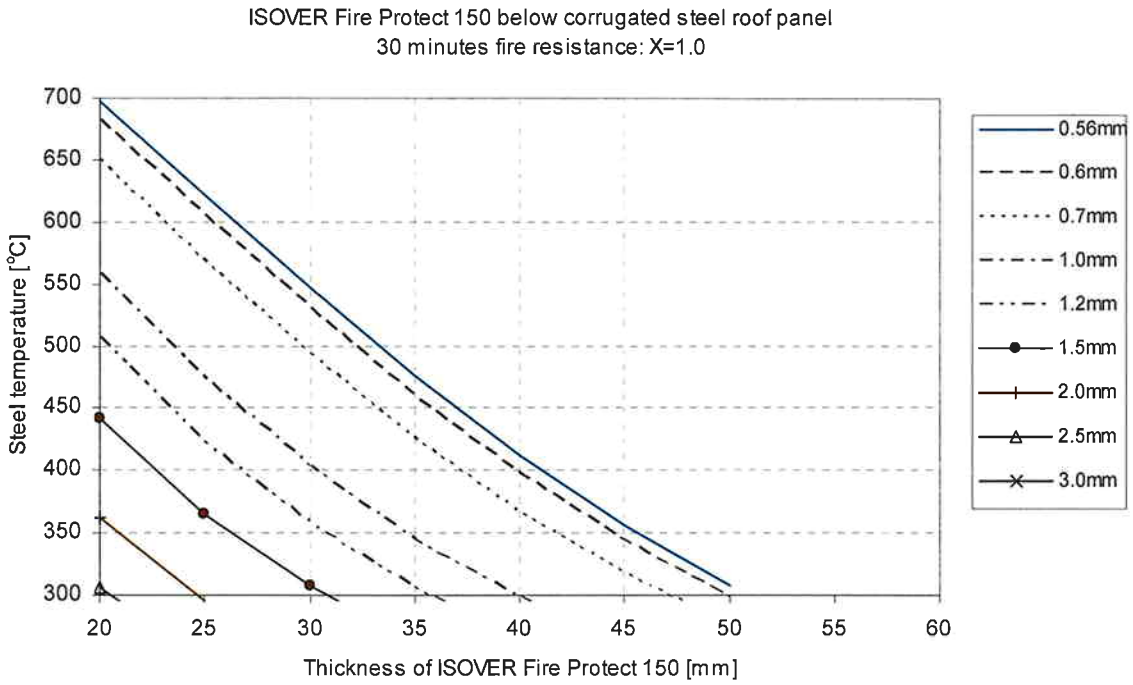


Figure B.1 **30 minutes resistance:** Design curves for Isover Fire Protect 150 for fire protection below corrugated steel roof panels subjected to Standard Fire Exposure from below.

Table B1 **30 minutes resistance:** Calculated steel temperatures in corrugated steel roof panel for different board thicknesses of Isover Fire Protect 150 subjected to Standard Fire Exposure from below.

Thickness of fire protection [mm]	Thickness of corrugated steel roof panel								
	0.56mm	0.6mm	0.7mm	1.0mm	1.2mm	1.5mm	2.0mm	2.5mm	3.0mm
20	**697**	**683**	**650**	**559**	**506**	**441**	**362**	**306**	**266**
25	**622**	**606**	**569**	**474**	**423**	**365**	**296**	**250**	**217**
30	**547**	**530**	**493**	**403**	**358**	**307**	**249**	**210**	**182**
35	**476**	**460**	**425**	**345**	**306**	**262**	**213**	**180**	**156**
40	**412**	**398**	**367**	**298**	**265**	**227**	**184**	**156**	**136**
45	**356**	**345**	**318**	**259**	**230**	**198**	**162**	**137**	**120**
50	**308**	**299**	**277**	**226**	**202**	**174**	**143**	**122**	**107**

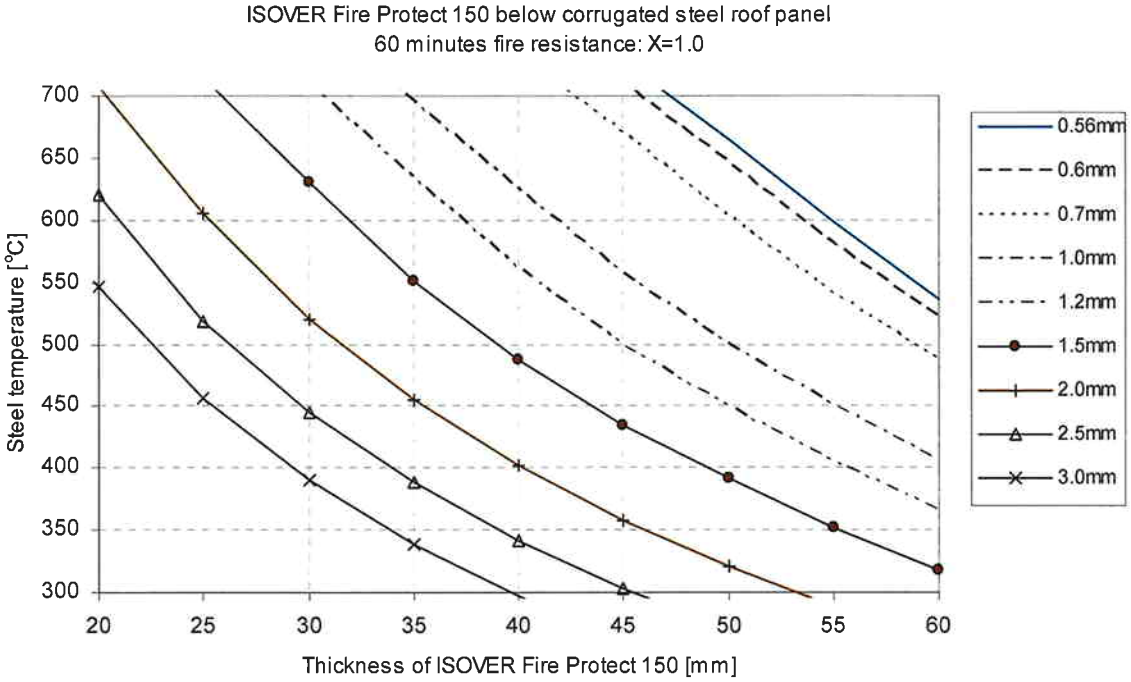


Figure B.2 **60 minutes resistance:** Design curves for Isover Fire Protect 150 for fire protection below corrugated steel roof panels subjected to Standard Fire Exposure from below.

Table B.2 **60 minutes resistance:** Calculated steel temperatures in corrugated steel roof panel for different board thicknesses of Isover Fire Protect 150 subjected to Standard Fire Exposure from below.

Thickness of fire protection [mm]	Thickness of corrugated steel roof panel								
	0.56mm	0.6mm	0.7mm	1.0mm	1.2mm	1.5mm	2.0mm	2.5mm	3.0mm
20						799	708	621	547
25					784	715	606	519	456
30				766	710	630	520	445	390
35			793	696	633	551	455	388	338
40	786	771	734	625	561	488	402	341	297
45	728	711	670	557	500	435	357	303	263
50	664	646	603	500	449	391	320	271	236
55	598	580	541	451	405	352	288	244	212
60	536	521	487	407	366	318	260	221	192

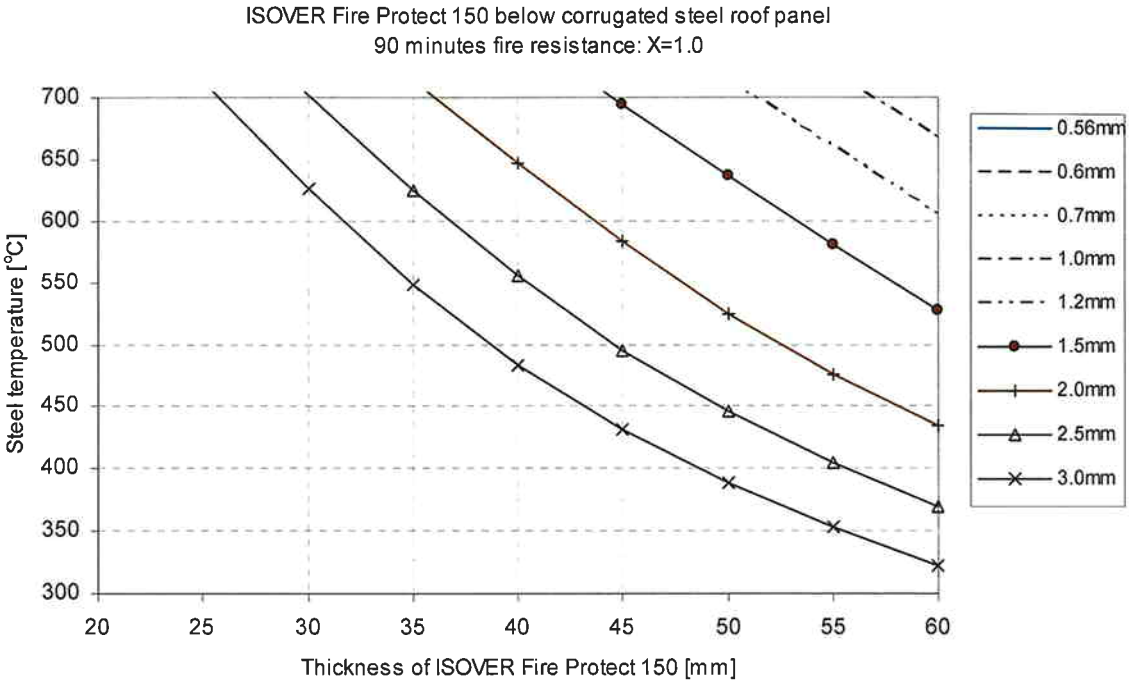


Figure B.3 **90 minutes resistance:** Design curves for Isover Fire Protect 150 for fire protection below corrugated steel roof panels subjected to Standard Fire Exposure from below.

Table B.3 **90 minutes resistance:** Calculated steel temperatures in corrugated steel roof panel for different board thicknesses of Isover Fire Protect 150 subjected to Standard Fire Exposure from below.

Thickness of fire protection [mm]	Thickness of corrugated steel roof panel								
	0.56mm	0.6mm	0.7mm	1.0mm	1.2mm	1.5mm	2.0mm	2.5mm	3.0mm
20									
25								781	713
30							783	701	626
35							714	625	548
40						753	647	556	483
45					769	694	584	495	432
50				771	714	636	525	446	389
55				719	660	580	476	405	353
60		799	765	667	606	528	434	369	322