

INDIAN METAL BUILDING FORUM

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Connecting India's Metal Building Ecosystem

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RESOURCE CENTRE

Technical Knowledge Series

STEEL STRUCTURE FAILURE & LESSONS LEARNED

Steel Exhibition Hall Roof Collapse: Snow and Ice Load on an Under-Strength Series System

Katowice Fair Building, Chorzow / Katowice, Poland | 28 January 2006

Learn from Failure
Improve the System
Prevent Recurrence

CASE STUDY NO:	IMBF-SF-004
COUNTRY:	Poland
YEAR:	2006
STRUCTURE TYPE:	Single-storey steel exhibition hall; truss roof on cantilever columns
TECHNICAL CATEGORY:	Steel industrial and commercial buildings / Snow loading / Structural system robustness

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IMBF publishes this educational case study. IMBF was not the designer, builder or investigator of the structure.

A DOCUMENT CONTROL AND STATUS

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- ☒ Research Draft (compiled from referenced public sources; not yet reviewed)
- ☐ Technical Review
- ☐ IMBF Approved for Publication

This draft must not be marked approved until an authorised IMBF reviewer has checked it against the primary investigation report listed in the Source Register.

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The technical explanations and lessons presented are intended for general educational and professional-development purposes. They shall not be used as a substitute for: project-specific structural design; engineering calculations; site investigation; competent structural-engineering review; statutory approval; manufacturer instructions; applicable codes and standards; independent inspection; accredited testing or certification.

Readers must verify project-specific requirements with qualified professionals and the applicable statutory and code requirements. Where facts are uncertain or disputed, this document identifies them as such.

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How to read the references. Tags such as [S1] point to the Source Register on the last page. Text marked "IMBF interpretation" is engineering commentary by this series and is not a finding of the original investigators.

1 EXECUTIVE SUMMARY

Question	Answer
What happened?	The steel roof of an exhibition hall collapsed onto visitors during a trade fair. [S1] [S2]
Where?	Katowice International Fair, in Chorzow next to Katowice, Poland. [S2]
When?	28 January 2006, at about 17:15 local time. [S1] [S2]
What structure?	A steel hall about 96.4 m x 102.9 m in plan, with a truss roof on 6 internal and 66 external columns. In service from April 2000. [S1]
What failed?	Roof trusses, main girders and main columns that formed a series system, with no alternative load path. [S1]
Why?	The structural arrangement was wrong, the main members lacked strength and stiffness even for code loads, and a thick layer of ice and snow overloaded the roof. A local roof failure in January 2002 had been repaired and the hall kept in use. [S1]
Consequence?	65 people died. Injury figures differ by source: 130 heavily injured in [S1]; more than 170 injured in [S2].
Main lesson	Snow was the trigger. The cause was an under-designed, non-redundant structure that had already given a warning four years earlier.

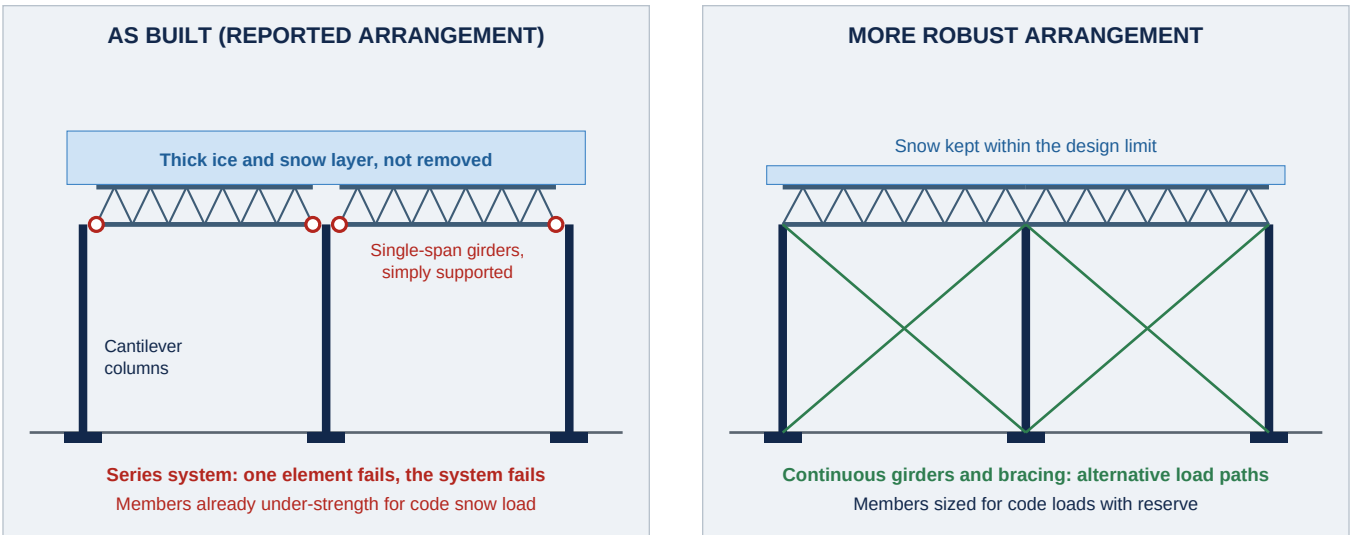


Figure 1. Original IMBF schematic of the reported structural system and a more robust alternative. Conceptual, not to scale; number of bays and members simplified.

2 PROJECT BACKGROUND

Only data found in the consulted sources is listed. Missing data is stated as not established rather than estimated.

Item	Verified data	Source
Purpose	Exhibition hall. An international pigeon exhibition was in progress, with roughly 700 people inside.	[S2]
Plan size	96.360 m x 102.875 m.	[S1]
Height	13.2 m over a central part of 47.00 m x 52.75 m; 10.2 m elsewhere.	[S1]
Roof shape	Central raised lantern 3.0 m high, plus eight lanterns of 6 m x 6 m and 2 m high on the roof.	[S1]
Structural system	Single-span truss girders and purlins carrying load to single-span main truss girders, supported on cantilever columns: a series system.	[S1]
Supports	6 internal columns and 66 external columns along the walls.	[S1]
Number of floors	Single storey (hall). Further levels: Not established in the available source.	[S1]
In service from	April 2000.	[S1]
Earlier damage	Local roof collapse in January 2002; repairs from January to September 2002.	[S1]
Conditions at failure	Thick ice and snow cover on the roof; very cold weather.	[S1] [S2]
Steel grades, member sizes, connection types, snow depth	Not established in the available source.	-

3 FAILURE TIMELINE

DESIGN	Hall designed with structural-arrangement and strength errors: series system, weak bracing arrangement, under-strength trusses, girders and columns. [S1]
PROCUREMENT	Not established in the available source.
FABRICATION	Field connections of assembly units are among the items criticised by the investigators; details: Not established in the available source. [S1]
ERECTION	Erection details: Not established in the available source. Hall in service from April 2000. [S1]
DEFECT / CHANGE	January 2002: local collapse of the roof under snow. Repaired by September 2002 and returned to use. A tertiary source reports that the repair was done without building-inspector clearance or a strength check. [S1] [S2]
TRIGGER EVENT	January 2006: thick ice and snow layer on the roof, reported as not removed. [S1] [S2]
LOCAL FAILURE	An element of the series system reached its capacity. Which member failed first: Not established in the available source.
PROGRESSIVE FAILURE	With no alternative load path, failure spread through trusses, girders and columns. [S1]
COLLAPSE	Central roof slid down to floor level; the lower roof around it collapsed or displaced. 65 dead. [S1]
INVESTIGATION	Engineering investigation by specialists of Wroclaw University of Technology, published in a peer-reviewed journal; official commission preliminary report on 31 March 2006; criminal investigation closed June 2008. [S1] [S2]

CORRECTIVE ACTION

Whether the hall was rebuilt: Not established in the available source. Court convictions followed. A tertiary source reports a law change requiring twice-yearly inspection of large buildings; to be verified. [S2] [S3]

4 WHAT FAILED?

Element	Identification
Primary failed component	Main roof-bearing structure: trusses, main truss girders and main columns. First member to fail: Not established in the available source. [S1]
Secondary failed components	Purlins, secondary trusses and roof covering over the central and lower roof areas. [S1]
Connection involved	Supports of main girders on columns and field connections of assembly units are named as deficient. [S1]
Load path involved	Snow and roof covering -> purlins and trusses -> main truss girders -> cantilever columns -> foundations.
Failure mode	Overload of under-strength members in a series system, leading to total progressive collapse. [S1]

5 ENGINEERING FAILURE MECHANISM

Series system. Each single-span member rested on the next, and the columns were cantilevers. Such a system has the strength of its weakest element: when one reaches capacity, nothing else can take over. [S1]

Insufficient strength. Static checks by the investigators showed that most trusses and main and secondary girders exceeded design strength by 26.8 % to 113.5 %, and main columns by up to 130.9 %, under the basic code loads of snow, self-weight, covering and services. The structure was unsafe before any exceptional snow. [S1]

Insufficient rigidity and bracing. The arrangement of bracing and the stiffness of the main elements are listed among the causes. Flexible members deflect more, which on a nearly flat roof also encourages snow and meltwater to collect. [S1]

Roof shape. Lanterns and level changes create places where snow drifts and ice builds up, so local load can far exceed the uniform value. The shaping of the roof surface is one of the items the investigators assessed. [S1]

Snow and ice overload. A thick ice and snow layer was the final load. A tertiary source reports an overload of more than 100 %. [S1] [S2]

Mechanism considered	Role in this case
Snow loading	Trigger (reported). [S1]
Member overstress and buckling of trusses, girders and columns	Underlying cause (reported). [S1]
Bracing failure / lack of stiffness	Contributing (reported). [S1]
Progressive collapse	Spread of failure through a series system (reported). [S1]
Fatigue, corrosion, weld failure, wind, erection instability	Not reported as factors in the consulted sources.

6 ROOT-CAUSE ANALYSIS

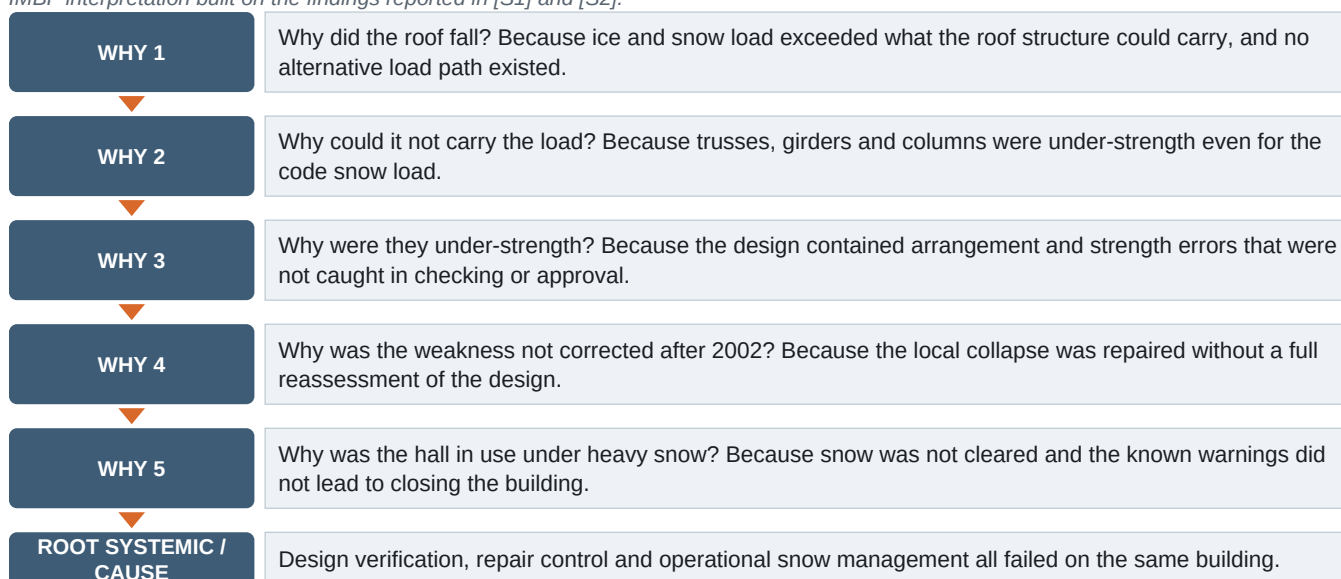
Area	Finding	Basis
Design	Wrong structural arrangement (series system on cantilever columns); members under-strength for code loads; inadequate bracing and stiffness; roof shape prone to accumulation.	Reported [S1]
Material	Not established in the available source.	-
Fabrication	Field connections of assembly units criticised; details not established.	Reported [S1]
Welding	Not established in the available source.	-
Bolting	Not established in the available source.	-

Area	Finding	Basis
Erection	Not established in the available source.	-
QA/QC	Design errors passed through checking and approval; the 2002 repair is reported as done without inspector clearance or verification calculations.	Reported [S2] (tertiary)
Operation	Snow and ice not removed from the roof; hall open to the public.	Reported [S1] [S2]
Maintenance	After the 2002 local collapse the roof was repaired, not reassessed and strengthened.	Reported [S1] [S2]
Management / communication	Owners are reported to have known of the problems and of advice to clear snow and verify the design.	Reported [S2] (tertiary)

Level	Statement
Immediate cause	Overload of the roof structure by a thick ice and snow layer. [S1]
Contributing causes	Series system without redundancy; weak bracing and stiffness; roof shape; snow not removed; earlier damage repaired without reassessment. [S1] [S2]
Root cause	A structure designed with insufficient strength and an unsafe arrangement was approved, built and kept in public use after a first failure had shown the weakness. (IMBF interpretation of [S1] and [S2])

7 FIVE-WHY ANALYSIS

IMBF interpretation built on the findings reported in [S1] and [S2].



8 CORRECTIVE ACTION

Immediate corrective action (as reported)

- Rescue and recovery operation in sub-zero temperatures; wreckage cleared by 19 February 2006. [S2]
- Engineering investigation of the structure, and a separate official commission and criminal investigation. [S1] [S2]
- Rebuilding of the hall: Not established in the available source.

Permanent corrective action (engineering remedy, IMBF interpretation)

- Design the primary structure with continuity and bracing so that the loss of one element does not bring down the roof.
- Size members for code loads, including drift and accumulation at lanterns, parapets and level changes.
- After any partial failure, reassess the whole design independently before repair and reuse.
- Give the owner a snow and roof-load management plan with a measurable limit and an instruction to clear or close.

9 PREVENTIVE ACTION (CAPA)

Problem	Root cause	Corrective action	Preventive action	Responsible party
Members under-strength	Design errors not caught	Strengthen or replace	Independent design check before approval	Designer; proof-checker; authority
No alternative load path	Series system on cantilever columns	Add continuity and bracing	Robustness requirement for public halls	Structural designer
Snow and ice build-up	No clearing; roof shape	Clear roof; add monitoring	Roof-load management plan with trigger levels	Owner; facility manager
Warning ignored	2002 failure repaired only	Full reassessment	Mandatory structural review after any partial failure	Owner; authority; engineer
Public exposed	Hall open while overloaded	Close until safe	Authority to close building when limit is reached	Owner; event organiser

10 QA/QC FAILURE ANALYSIS: WHAT SHOULD QA/QC HAVE DETECTED?

Original QA/QC records are not available in the consulted sources. The table shows what a robust system should check on a similar building (IMBF interpretation).

QA/QC area	Check relevant to this type of failure
Design verification	Independent calculation of main members, columns and bracing under code snow, including drift.
Material certificates and traceability	Steel grade as assumed in design; members traceable.
WPS / PQR, welder qualification, welding inspection, NDT	Shop and site welds in trusses and girder supports made and tested to specification.
Bolt certificates and installation	Field splices and support connections assembled as detailed.
Dimensional inspection and alignment	Truss geometry, column plumb and bearing seating within tolerance.
Bracing	All roof and wall bracing installed and connected before handover.
Drainage	Roof falls and outlets prevent meltwater and ice build-up.
Erection sequence	Temporary stability maintained; no member left unbraced.
As-built verification	As-built drawings and a record of any repair, with calculations, approved by the authority.
Coating	Not reported as a factor in this case.

11 IMBF OPTIMIZATION STRATEGY

Area	Optimisation
Design	Robustness check for every large-span public building; avoid pure series systems; design for drift at roof steps and lanterns.
Fabrication	Field connections designed and detailed to develop member forces; trial fit of critical splices.
QA/QC	Proof-check certificate as a hold point before fabrication release.
Erection	Bracing completed bay by bay; survey of deflection after cladding.
Digital traceability	Repairs and modifications logged against the building model with calculations attached.
Inspection	Scheduled structural inspection before and after the severe-weather season.
Maintenance	Roof-load plan: who measures, what limit, who clears, who closes.
Cost	Lowest-weight design is not lowest cost when reserve and redundancy are removed.
Safety	Occupancy-based importance: exhibition and assembly halls get higher scrutiny.

Area	Optimisation
Productivity	Standard braced-frame layouts reduce design errors and site improvisation.

12 DIGITALIZATION

- Roof-load sensors or simple snow and water depth gauges, with alerts to the facility manager.
- Deflection monitoring of main girders compared with predicted values.
- QR codes on main members linking to drawings, certificates and repair history.
- Digital inspection checklists with photographs for seasonal inspections.
- Cloud record of every incident, repair and engineering assessment for the life of the building.

DESIGN	Independent check recorded; design snow load and roof-load limit stated.
FABRICATION	Members marked and traced.
INSPECTION	Dimensional, weld and connection records with photographs.
DISPATCH	Scan-out against erection sequence.
ERECTION	Bracing and connection completion recorded bay by bay.
FINAL INSPECTION	As-built survey and approvals filed.
DIGITAL AS-BUILT / RECORD	Used for seasonal inspection, roof-load monitoring and repair history.

13 INDIAN CONTEXT: WHAT SHOULD INDIA LEARN FROM THIS FAILURE?

- Most of India has no snow, but the same pattern applies to other roof loads: ponded monsoon water, dust and ash on industrial roofs, added solar panels, services and hung equipment.
- In Himalayan and other snow regions, steel sheds, hangars and halls must be designed for snow, including drift at parapets, valleys and roof steps.
- PEB economy comes from optimised members. That makes independent design checking and robustness more important, not less.
- A local failure, a sagging purlin or a buckled member is a warning about the whole design. Repairing the visible damage is not enough.
- Owners of large halls should hold a roof-load plan and arrange periodic structural inspections.

Reference	Subject	Relevance to this case
IS 800	General construction in steel: code of practice	Member strength, stability, bracing and structural integrity.
IS 875 (Part 4)	Snow loads	Roof snow load and accumulation in snow regions.
IS 875 (Part 1 and Part 2)	Dead and imposed loads	Self-weight, services and roof imposed loads.
IS 875 (Part 3) and IS 1893	Wind and earthquake loads	Other governing load cases.
IS 2062	Hot-rolled structural steel	Material conformity.
Project specification and ITP	Contract documents	Proof-checking, repair control and handover of operating limits.

Clause numbers are deliberately not cited. Standard titles and current editions must be confirmed against Bureau of Indian Standards publications at technical review.

14 IMBF PREVENTION CHECKLIST

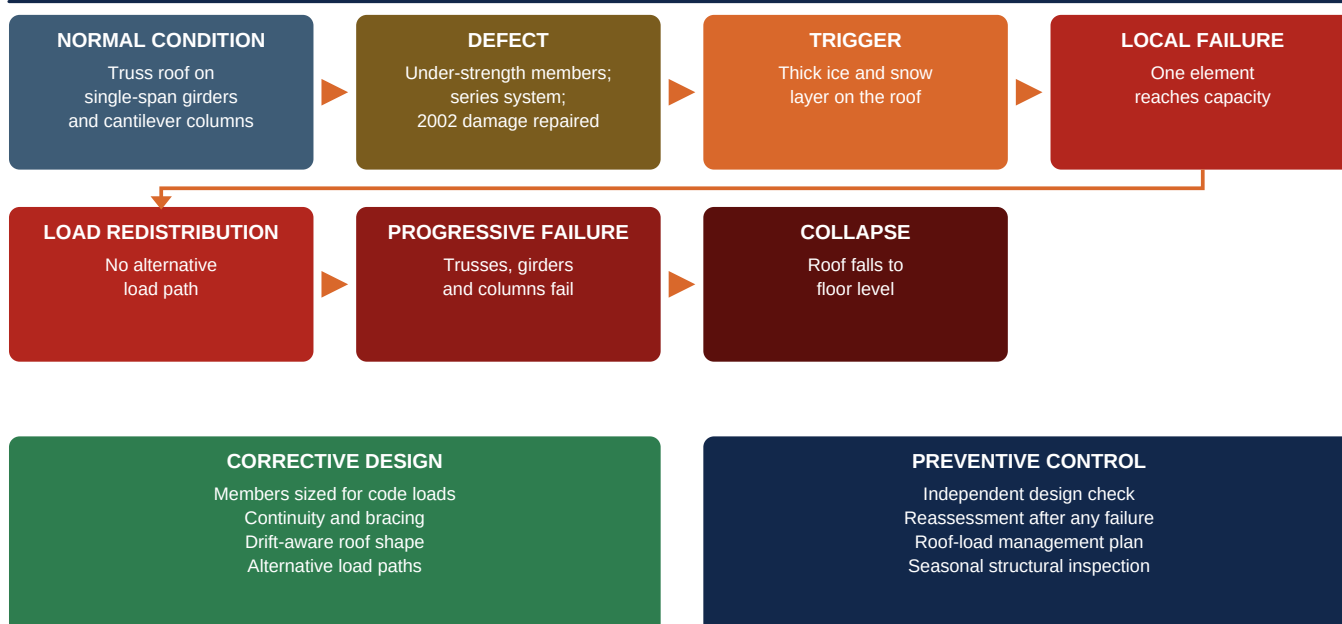
Inspection point	Required check	Status	Remarks
Design review	Independent check of main members, columns and bracing; robustness assessed	☐	
Connection review	Girder supports and field splices designed for member forces	☐	
Material traceability	Steel conforms to specification; members traced	☐	
Welding	Qualified WPS and welders for truss and support welds	☐	
NDT	Critical welds tested to the specified extent	☐	
Bolting	Field connections installed and tightened as detailed	☐	
Dimensional inspection	Truss geometry, bearings and column plumb within tolerance	☐	
Bracing	All bracing installed and connected	☐	
Erection sequence	Stability maintained at every stage	☐	
Coating	Protection complete	☐	
Drainage	No snow, ice or water traps; outlets clear	☐	
Final inspection	Roof-load limit and management plan issued to owner	☐	
As-built documentation	As-built drawings and all repair assessments approved and filed	☐	

15 PHOTOGRAPHS

No third-party photograph is reproduced in this document. Published photographs and report figures exist, but their copyright and publication permission were not established for this series, so they are not used. All figures here are original IMBF schematics.

Photo source	Copyright	License	Permission
None reproduced	Not applicable	Not applicable	Not applicable

16 ORIGINAL IMBF FAILURE DIAGRAM



Original IMBF schematic. Conceptual, not to scale.

17 LESSONS LEARNED

5 engineering lessons

1. A series system is only as strong as its weakest member.
2. Design for snow drift and ice, not only uniform snow.
3. Stiffness and bracing matter as much as strength.
4. Check columns and supports, not only roof members.
5. Provide an alternative load path in public halls.

5 management lessons

1. Treat a partial failure as a warning about the whole.
2. Do not keep a doubtful building open to the public.
3. Fund roof clearing and inspection.
4. Act on expert advice in writing.
5. Define who can order closure.

5 QA/QC lessons

1. Require an independent design check.
2. Record and approve every repair with calculations.
3. Verify bracing and field connections on site.
4. Survey deflection after completion.
5. Keep as-built records for the life of the building.

5 preventive actions

1. Issue a roof-load limit at handover.
2. Inspect before and after the severe season.
3. Monitor roof load and deflection.
4. Train facility staff on warning signs.
5. Share this case with owners of large halls.

18 IMBF KEY MESSAGE

"Snow did not design this building. The roof at Katowice was under-strength and without a second load path from the day it opened, and it warned its owners in 2002. Check the design independently, respect the first failure, and manage roof loads in service."

19 SOURCE REGISTER

Ref	Source and organisation	Date	Used for	Consulted?
S1	Collapse of Katowice Fair Building. A. Biegus and K. Rykaluk, Wrocław University of Technology. Engineering Failure Analysis, vol. 16, issue 5, pp. 1643-1654. DOI 10.1016/j.engfailanal.2008.11.008 https://www.sciencedirect.com/science/article/abs/pii/S1350630708000263X	July 2009	Dimensions, structural system, history, causes, overstress percentages, casualties	Abstract and published section extracts; full text not read
S2	Katowice Trade Hall roof collapse. Wikipedia (tertiary), citing news reports and the official commission. https://en.wikipedia.org/wiki/Katowice_Trade_Hall_roof_collapse	Accessed 4 Oct 2026	Time, occupancy, event, commission and prosecution dates, snow-removal and 2002 repair statements, injury figure	Search extract only
S3	Press and secondary reports of the court verdicts and of the later law change on inspection of large buildings.	2006 onward	Convictions; inspection requirement (to be verified)	Search extracts only
S4	Zum Einsturz der Messehalle in Kattowitz. A. Biegus and K. Rykaluk. Bauingenieur, vol. 81.	Dec 2006	Cited by S1 for detailed strength analysis	No

Limits of this draft: only the abstract and the publicly shown section extracts of [S1] were read; the full paper and the official commission report were not. The introduction of [S1] prints the collapse date once as "January 01, 2006"; the abstract and all other sources give 28 January 2006. Statements tagged [S2] or [S3] come from tertiary sources and need confirmation.

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