Tall Buildings: Prevention at the Design Stage – The view of an Occupational Safety and Health Expert

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Nicosia,Cyprus
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Where I come from

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Antwerp

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Tall buildings of Antwerp

Cathedral

- Year: 1352-1521
- Height: 123 m

Tall buildings of Antwerp

‘Tower building’

- Year 1929-1932
- Height: 87,5m
- Heighest skyscraper of Europe in 1932

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Tall buildings of Antwerp

Name	Fina Antwerp Olefins Flare 4	Metallurgie Hoboken Chimney	Cathedral of Our Lady	KBC Tower	Antwerp Tower	Chicago Building	Park Tower	London Tower	Theater Building	Politietorer
City	Antwerp	Antwerp	Antwerp	Antwerp	Antwerp	Antwerp	Antwerp	Antwerp	Antwerp	Antwerp
Country	Belgium	Belgium	Belgium	Belgium	Belgium	Belgium	Belgium	Belgium	Belgium	Belgium
Illustrator	Ganymed	Furqan	F16 freak	THEc	THEc	THEc	THEc	THEc	THEc	THEc
Status	Built	Built	Built	Built	Built	Built	Built	Built	Built	Built
Built		1974	1521	1932	1974		2014	2010	1969	1967
Floors				26	25	27	22	24	21	17
Use	Industrial	Factory	Religious	Office	Office	Residential	Residential	Mixed use	Office	Office
Antenna				112.5 m						
Spire			123 m							
Roof	185 m	152 m		95.8 m	87 m	81 m	78.8 m	76.6 m	76 m	76 m

http://skyscraperpage.com/diagrams/?

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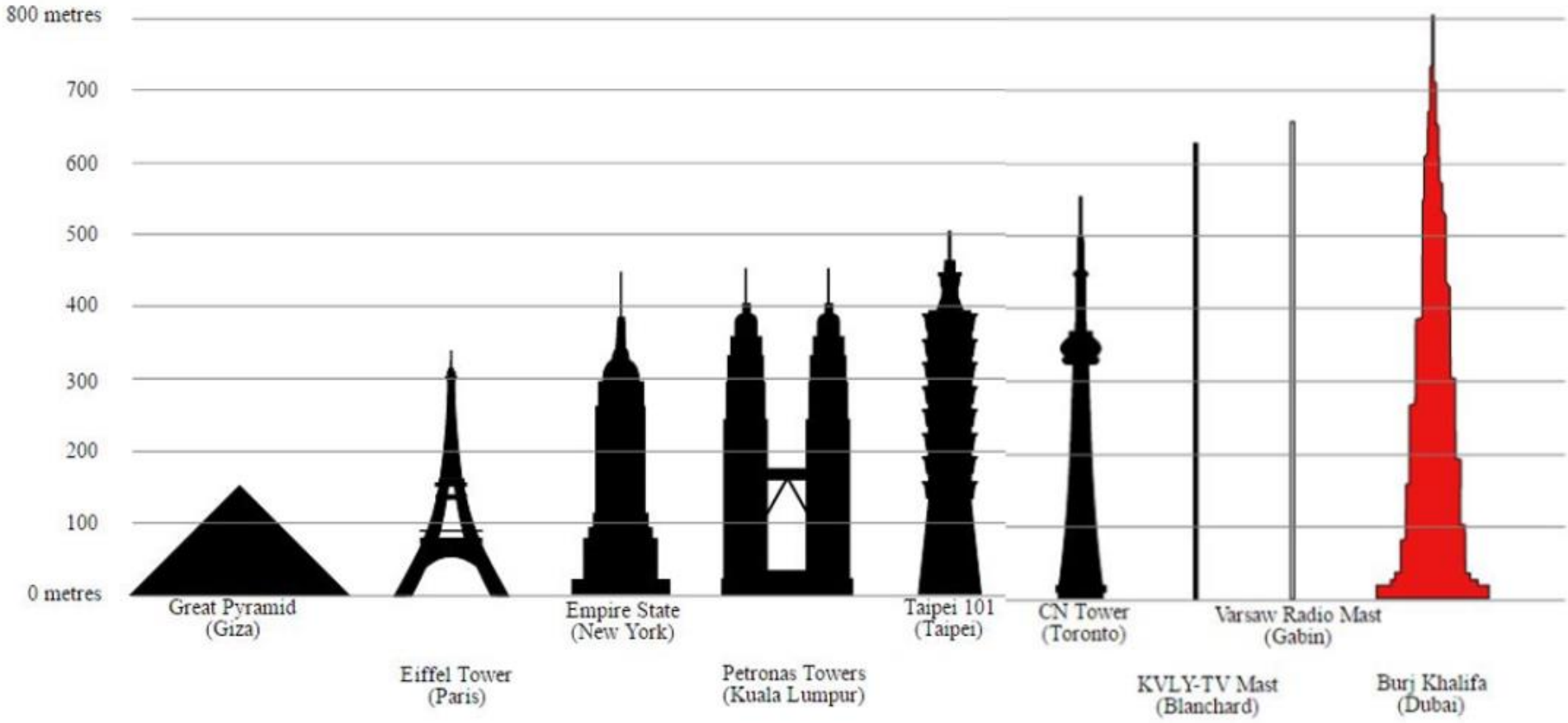
Tall buildings … New buildings?



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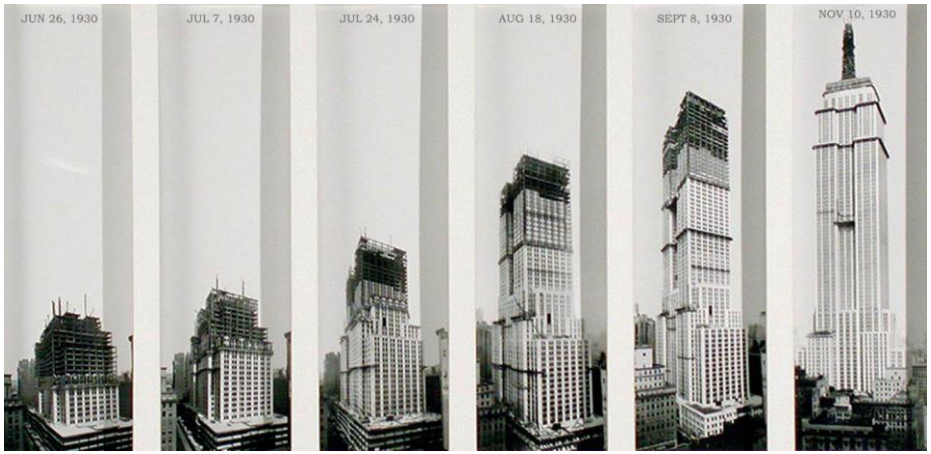
Empire State Building NY

- Ready in 1931
- 20 months from start to finish
- 3400 workers simultaneously
- At least 5 fatal accidents



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Design and prevention

Construction life cycle

- Design stage
- Procurement stage
- Construction stage
- Use and maintenance stage
- Demolition stage

Direct parties concerned

- Client - Owner
- Designer
- Contractor
- Construction worker
- Site manager
- Supplier
- Safety expert
- …

Role and impact of the designer

- Over 60%(*) of fatal accidents could have been avoided by taking action before opening the construction site

- Article 9 of the 167th ILO Convention:

  The designer must consider safety and health protection for construction workers

- EU 92/57

- The decisions taken during the initial cycles are the most strategic

(*) Source: ISSA-C

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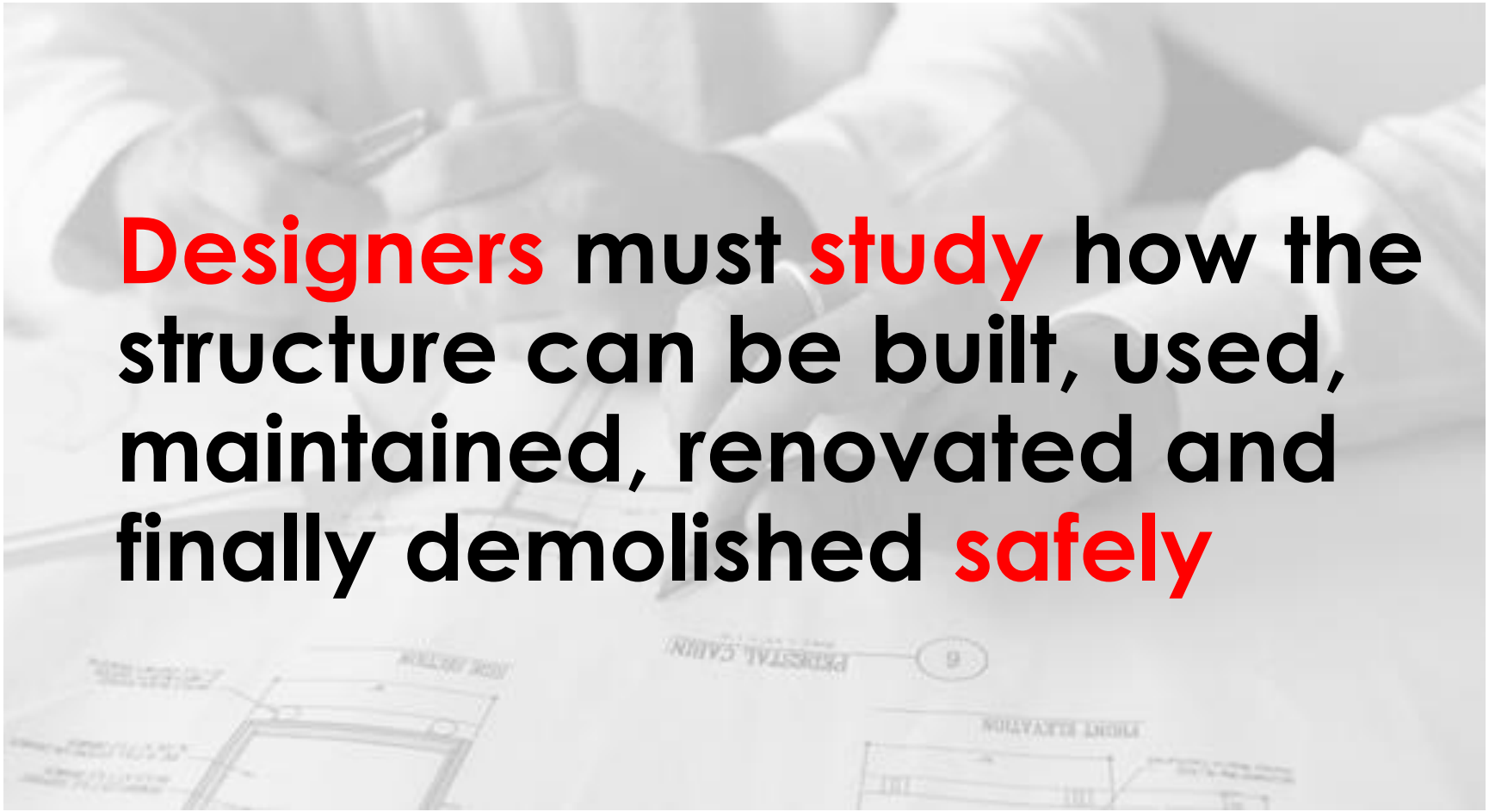
Role of the designer



Designers must study how the structure can be built, used, maintained, renovated and finally demolished safely

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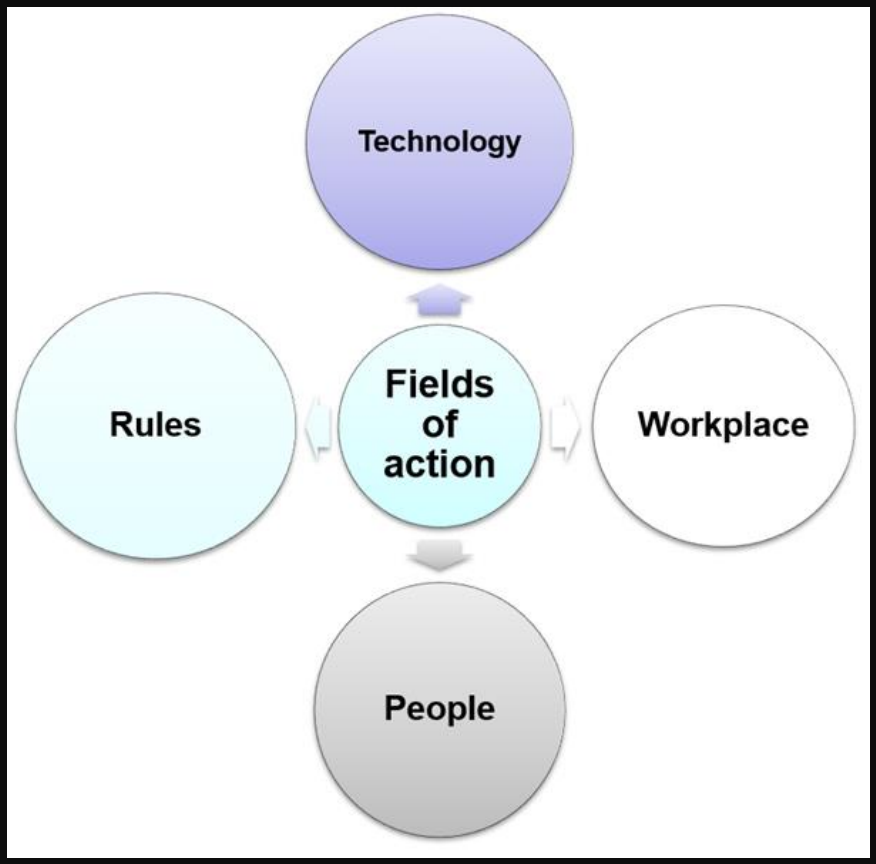
Management of Health and Safety: Fields of action



Example: pre-fabrication

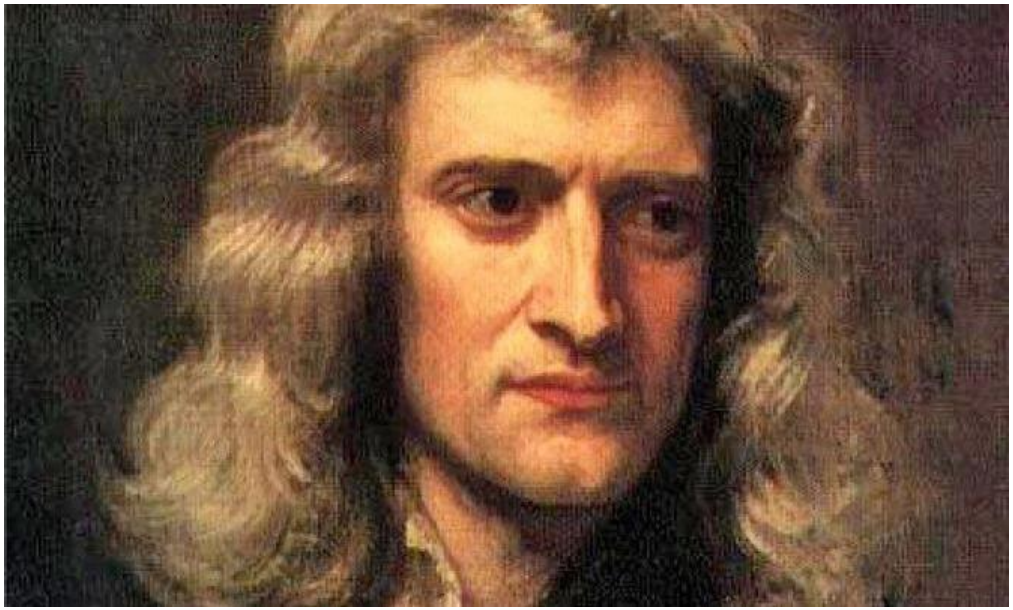
- Pre-fabrication and pre-assembly will likely increase worker safety
- Pre-fabrication reduces work at height

Recommendation 1

Be aware of the difference you can make as a designer regarding SH

Our old friends

Sir Isaac Newton (1643–1727)



Newton's first law: law of inertia

The first law can be stated mathematically when the mass is a non-zero constant, as,

$$SUM(F)=0 \iff dv/dt=0$$

Consequently

- An object that is at rest will stay at rest unless a force acts upon it
- An object that is in motion will not change its velocity unless a force acts upon it

Newton's second law

- $F = m.dv/dt = m.a$

Derived

- $G = m.g$

Newton

$(kg.m/s^2)$

Where

- $g = 9{,}81 m/s^2$ = acceleration of free fall
- m = mass of the body
- G = Weight of the body

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Newton's third law

- To every **action** there is always opposed an equal **reaction**

or

- The mutual actions of two bodies upon each other are always equal, and directed to contrary parts

Potential Energy

$$E_p = m.g.h$$

Joule

(kg.m/s^2.m= N.m)

Kinetic Energy

$$E_k = 1/2\ m\ v^2$$

Joule

(kg.m/s^2.m= N.m)

Law of conservation of mechanical Energy

$$E = E_p + E_k$$

Joule

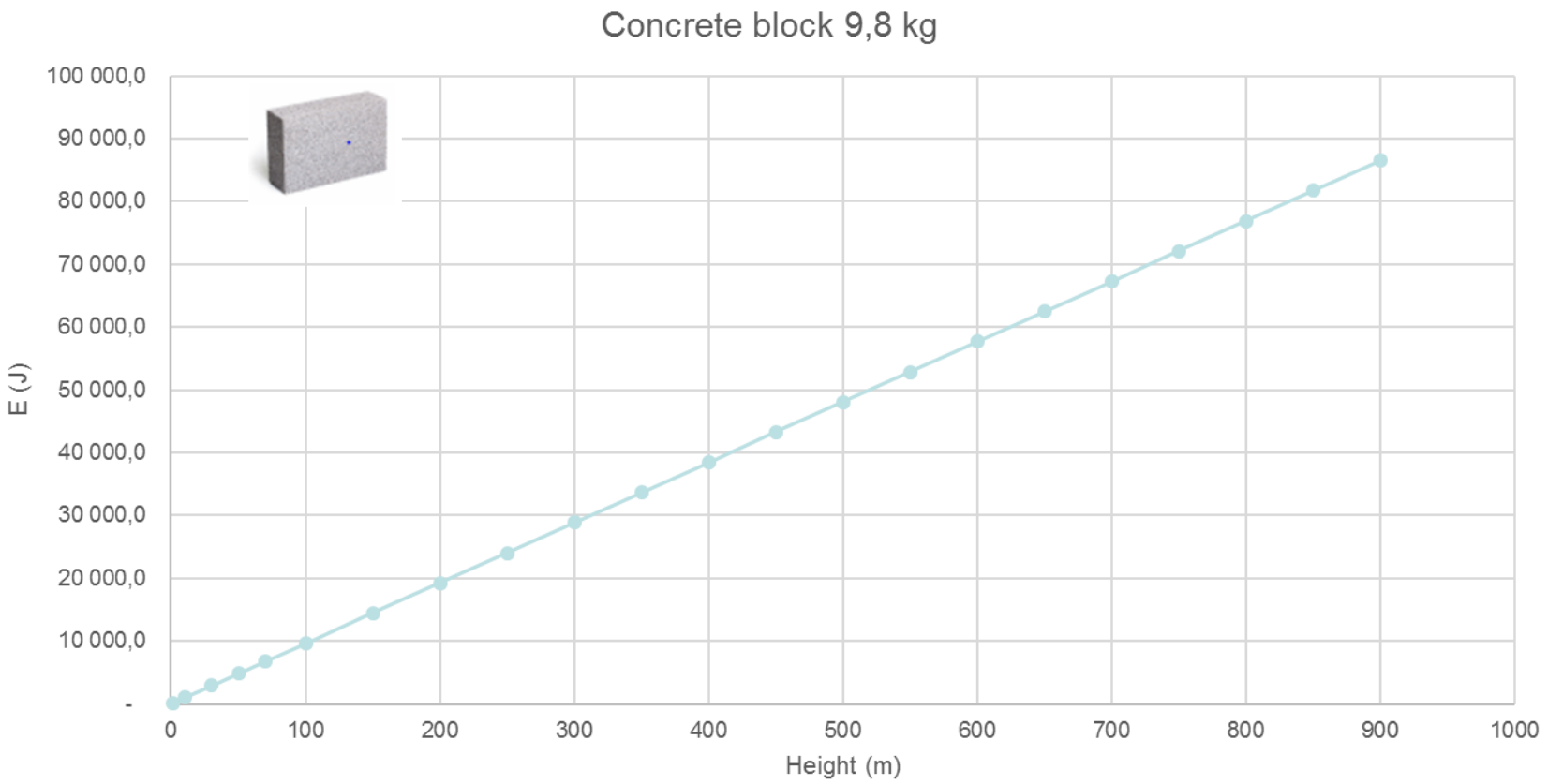
($kg.m/s^2.m = N.m$)

Impact on human head

University Bern (CH)

- 100J: Fracture of human scull
- 200J: Fatal

Impact of a concrete block



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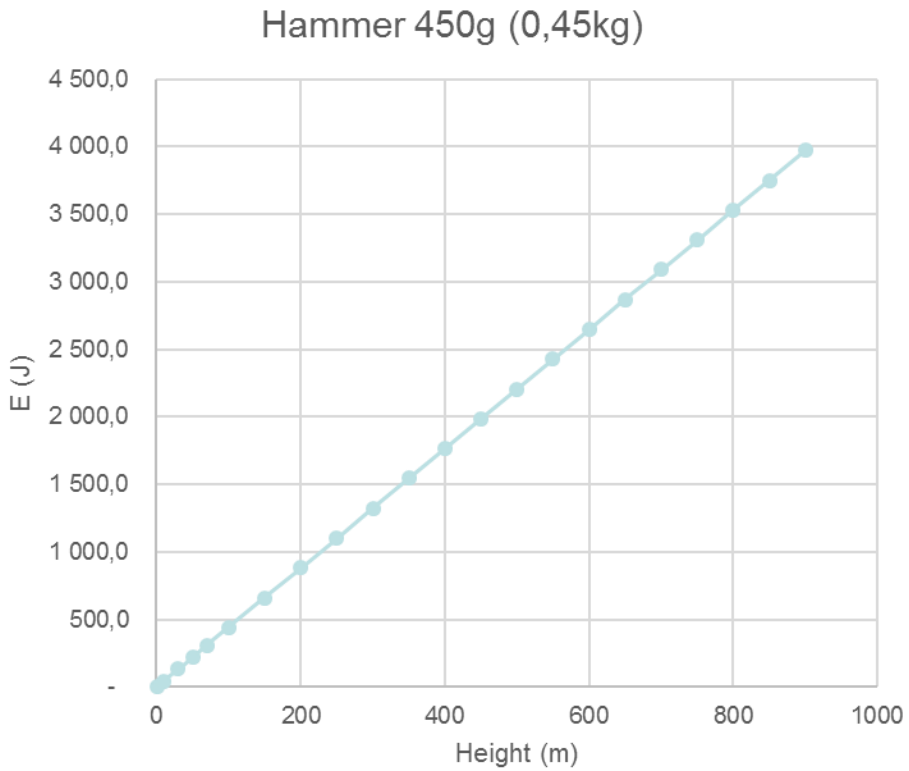
Impact of fall of a hammer of 450g



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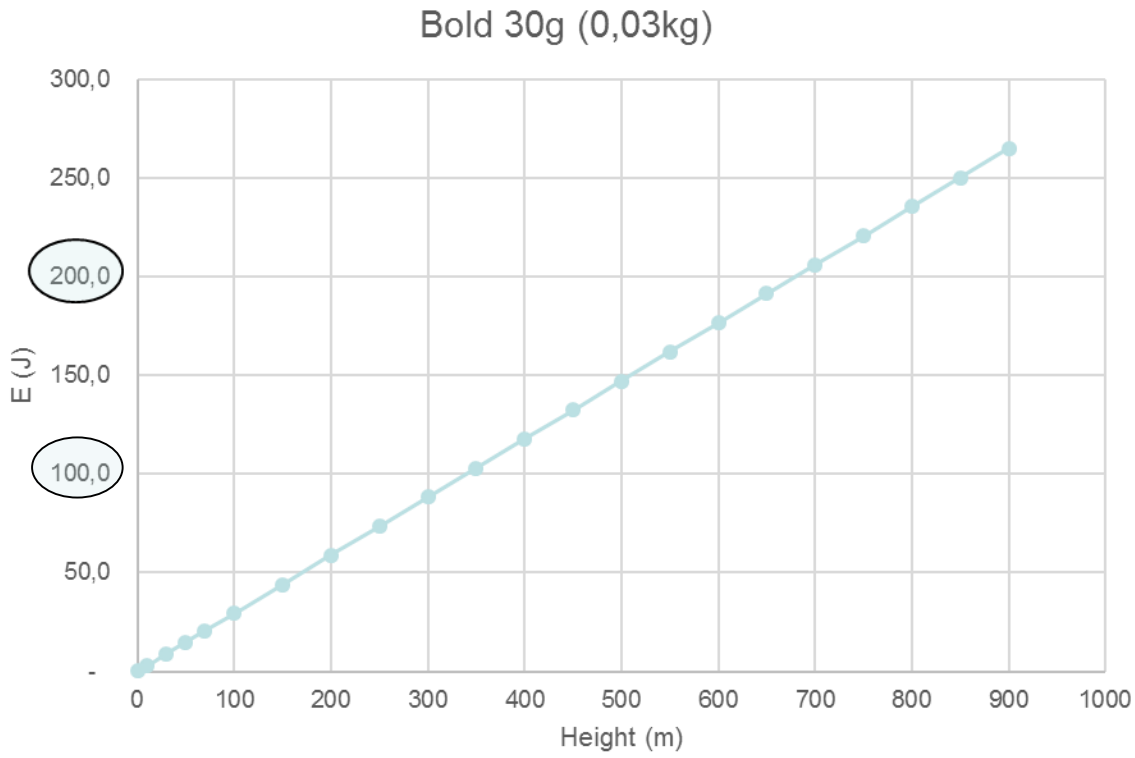
Impact of fall of a bold of 30g



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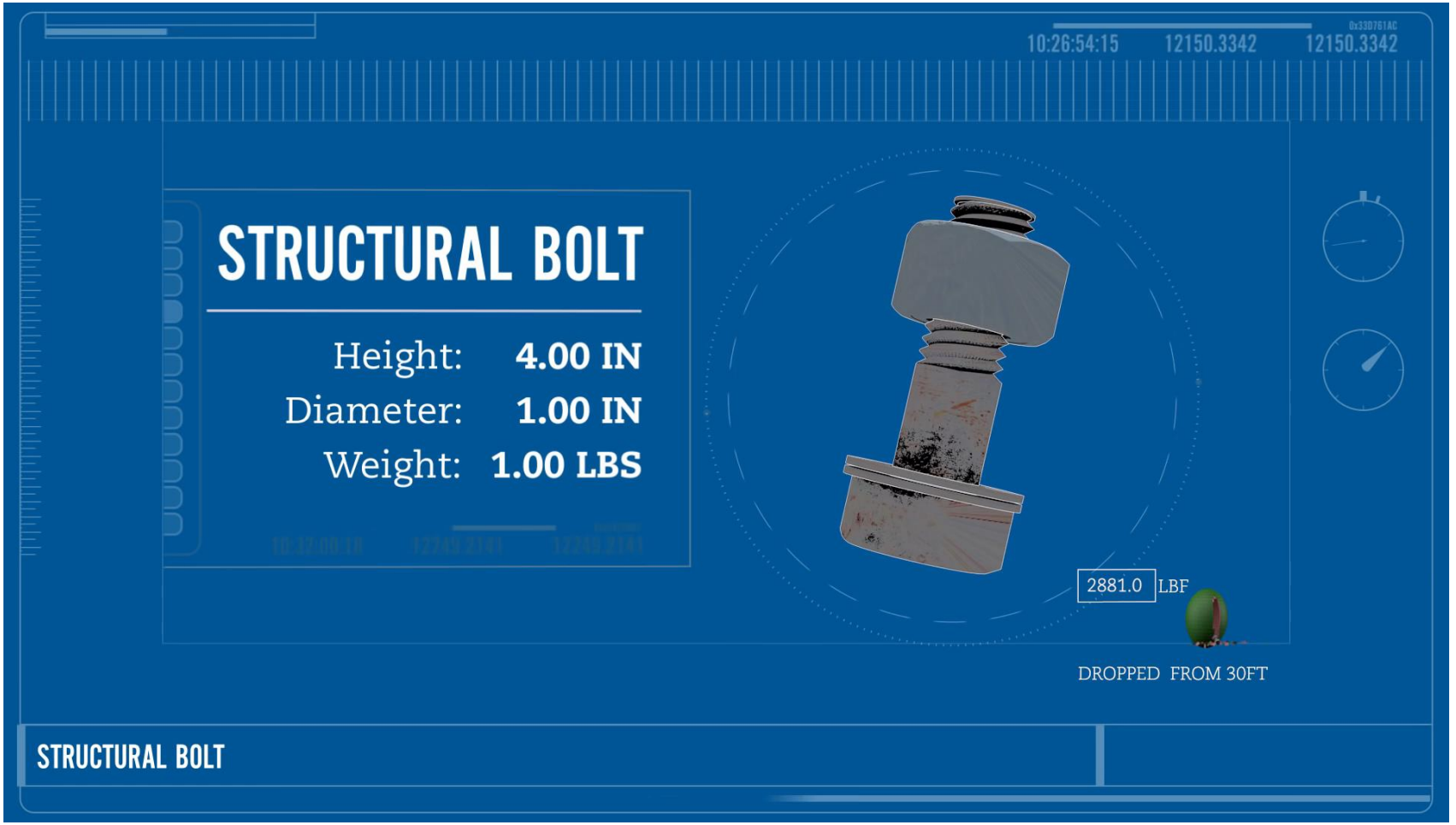
10:26:54:15
12150.3342
12150.3342
STRUCTURAL BOLT
Height: 4.00 IN
Diameter: 1.00 IN
Weight: 1.00 LBS
2881.0 LBF
DROPPED FROM 30FT
STRUCTURAL BOLT

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Recommendation 2

Stop dropped objects

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Preventing dropped objects

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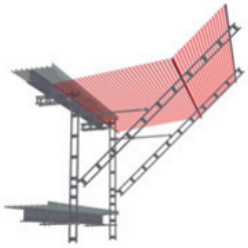
Safety nets

http://combisafe.com/EN/products/fall-safety/safety-net-fan/safety-net-fan-high-rise

Safety Net Fan High Rise



Make an enquiry

Request a site visit

Share on:

Details | **Resources** | **Related projects**

Art No. (Made to Order Only)

The Safety Net Fan High Rise has been designed specifically for the High Rise construction industry and can withstand winds of up to 100mph

It utilises the Class B1 net and comes with 60 x 60mm mesh and 20mm x 20mm debris net as standard, which has been proven to arrest falls of up to 100kg from a height of 6m, conforming to EN1263-1&2 (Safety Nets).

The elasticity of the net, together with a slight deformation of the frame, ensures that the impact of a fall is absorbed, considerably decreasing the risk of injury or objects falling to street level. Items do not bounce out or shatter which can harm people and property below. B1 nets that comply with EN1263-1&2 are significantly stronger than conventional methods of protection, as well as being energy absorbent, absorbing up to 4.4 kJ.

The combined layer net is able to catch considerably smaller particles of debris therefore protecting property and people at ground level. Fans can be folded in to retrieve fallen objects.

- Designed to withstand wind gusts of up to 100mph
- Made for catching material
- Compliments high rise construction
- 60mm x 60mm net overlay with 20 mm x 20mm* debris netting.
- 6m long by 4.6m wide
- High energy absorbing nets and frame assembly
- Folds up against the facade for easy crane access below or as a safety precaution during bad weather

*on the main inner section only, not on the kicker 'Up section'

NOTE: This product is a special solution, made to order only.

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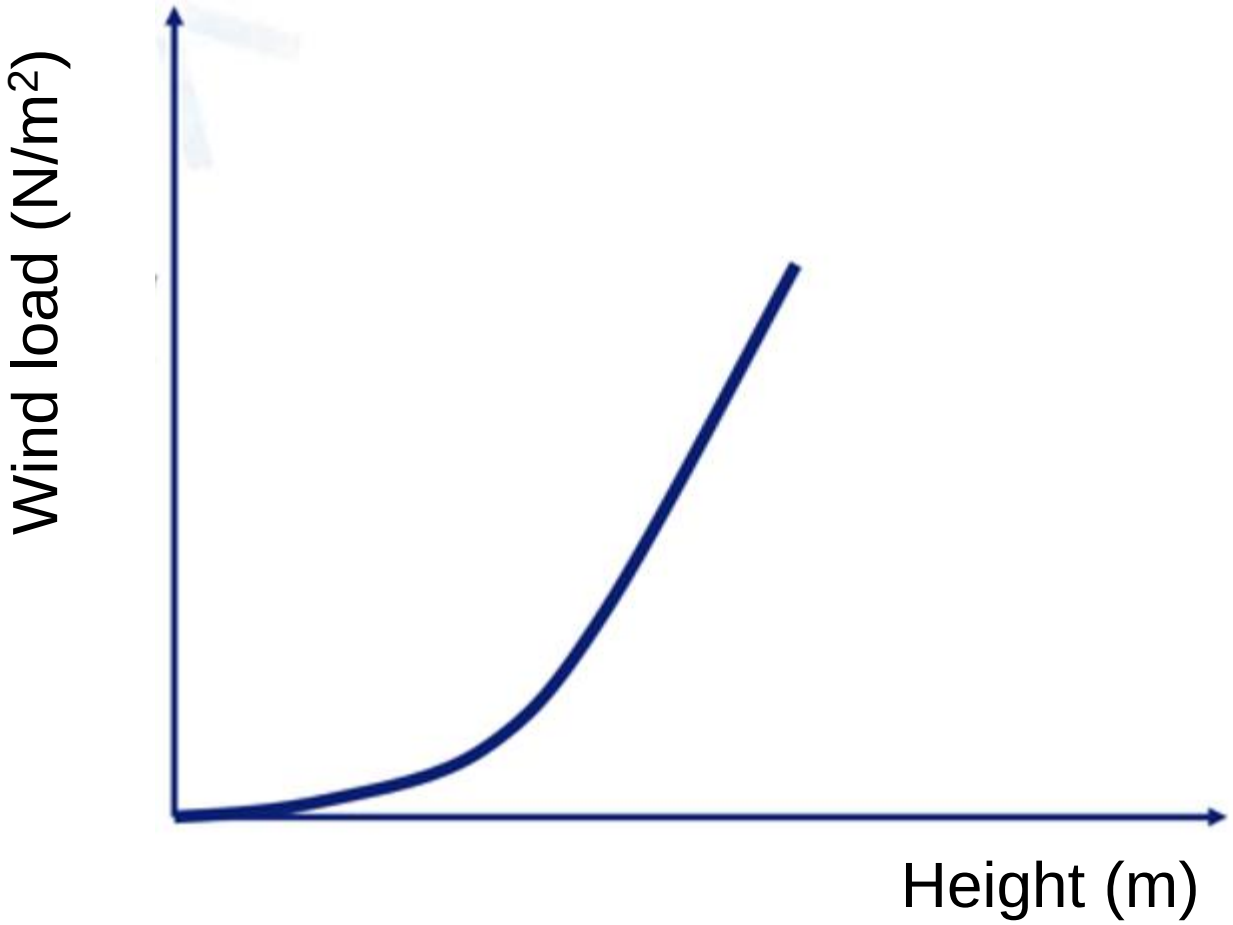
The force of nature

Wind and structural design

- Structural integrity under ultimate loads
- Deflections under service loads
- Building motion and occupant comfort
- Uncertainties in building structural properties like stiffness and damping
- Uncertainties in wind loading
- Uncertainties in wind climate
- Fluid dynamics

Relationship between height and the importance of wind loads



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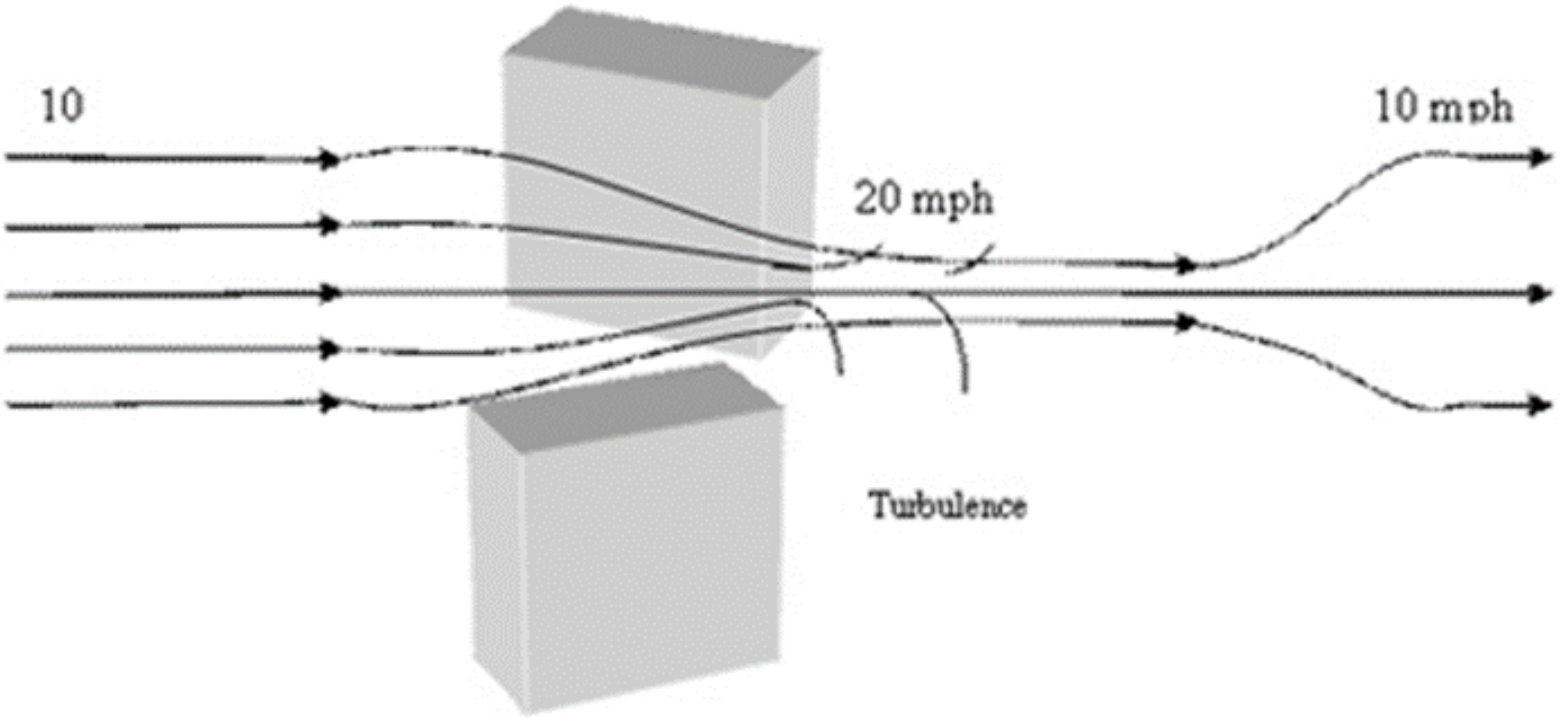
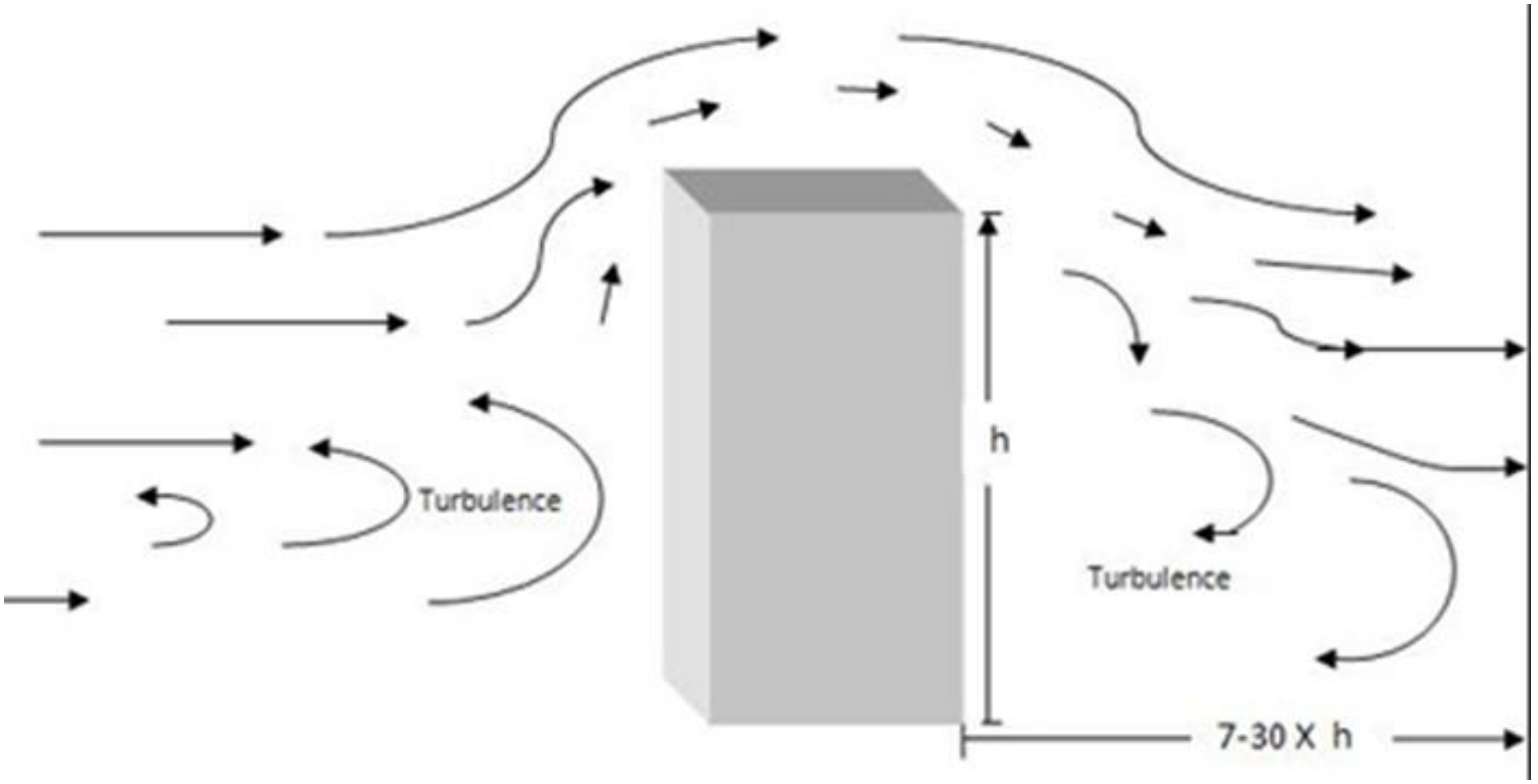
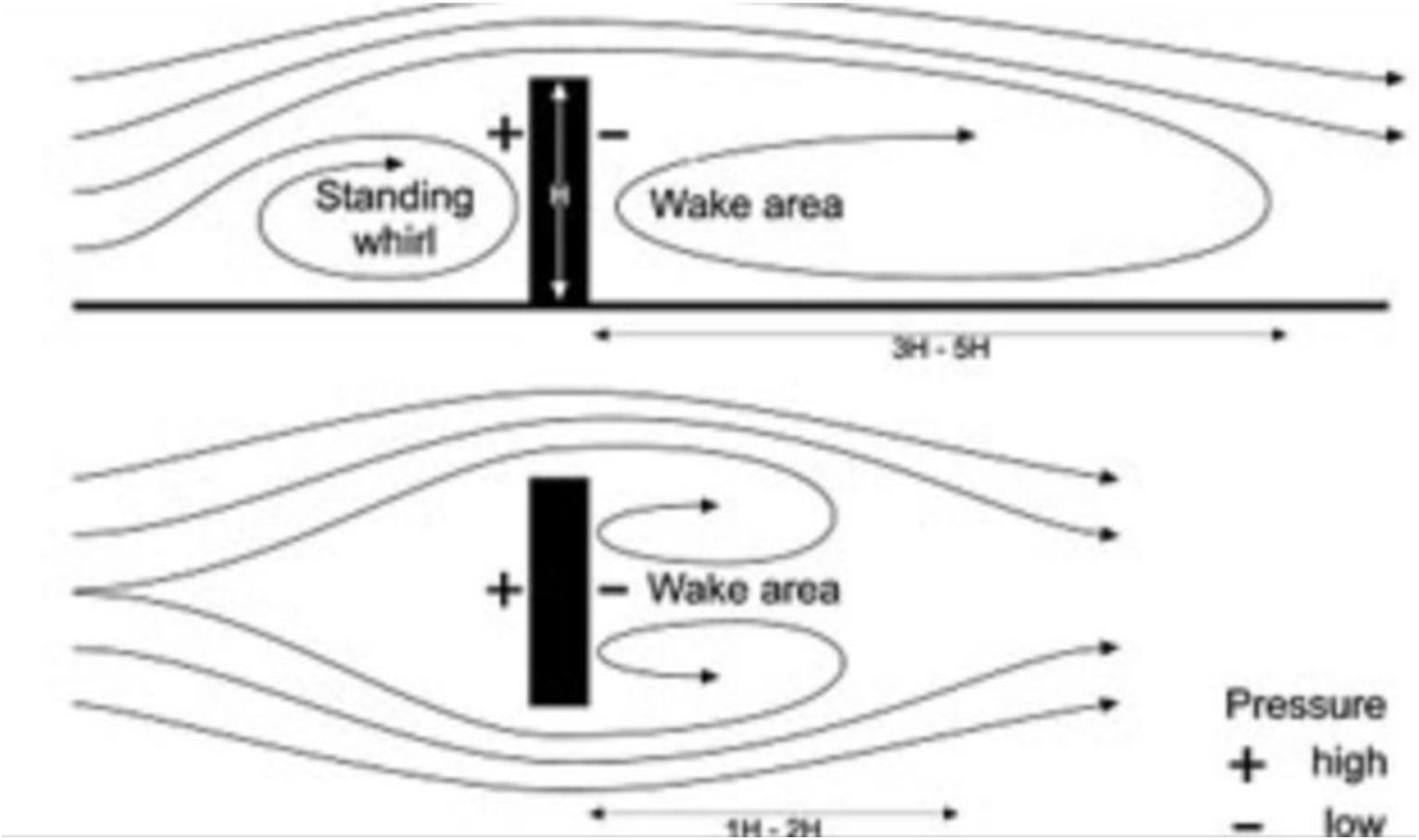
Wind flow between buildings



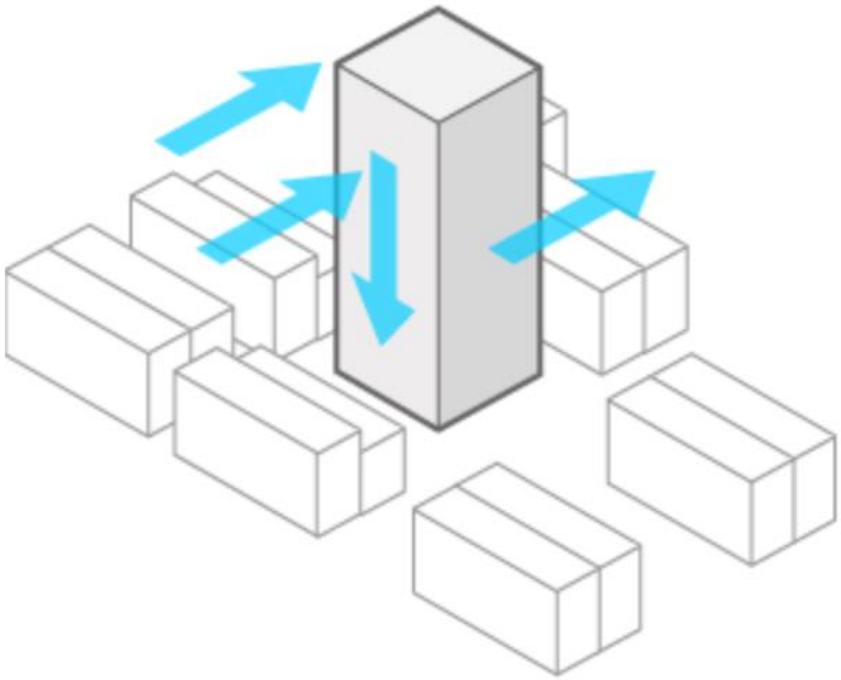
Wind flow over tall buildings

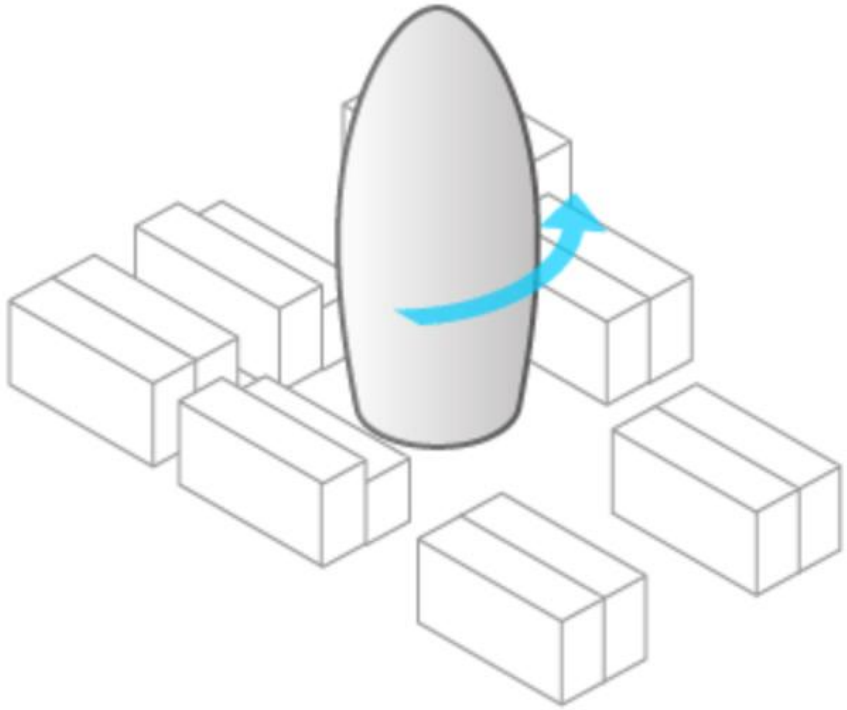


Pressure


+
−
Standing whirl
Wake area
3H - 5H
+
−
Wake area
1H - 2H
Pressure
+ high
− low

Aerodynamic buildings





Scale wind tunnel tests

Source: Peter A. Irwin RWDI

What about scaffolds?

From: Worksafe Victoria (Australia)

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Recommendation 3

Assess the impact of wind also on scaffolds, platforms and temporary structures

Make sure that...

- All scaffolds in wind exposed locations are designed to withstand likely environmental loads, including wind and rain.
- The design of a sheeted scaffold in any wind-exposed location is approved by a competent person.
- Where buildings or structures are being demolished, any adjacent scaffold is also progressively dismantled or, when it is still required, that it has been appropriately strengthened to withstand any increased wind loads.
- Planks on high scaffolds in wind-exposed locations are properly fixed against uplift.

When different people are working together

Culture and communication

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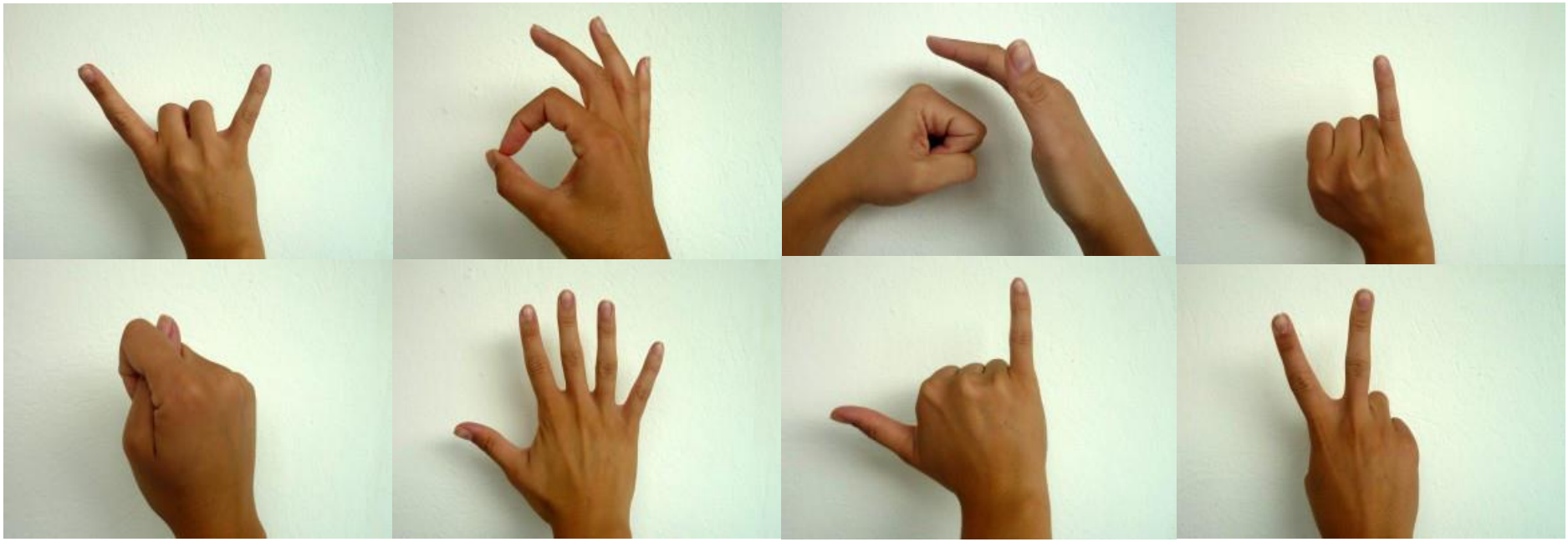
Cultural diversity

Same gestures... different meanings



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Languages and communication

Worldwide

- 7.000 official languages
- 20.000 dialects

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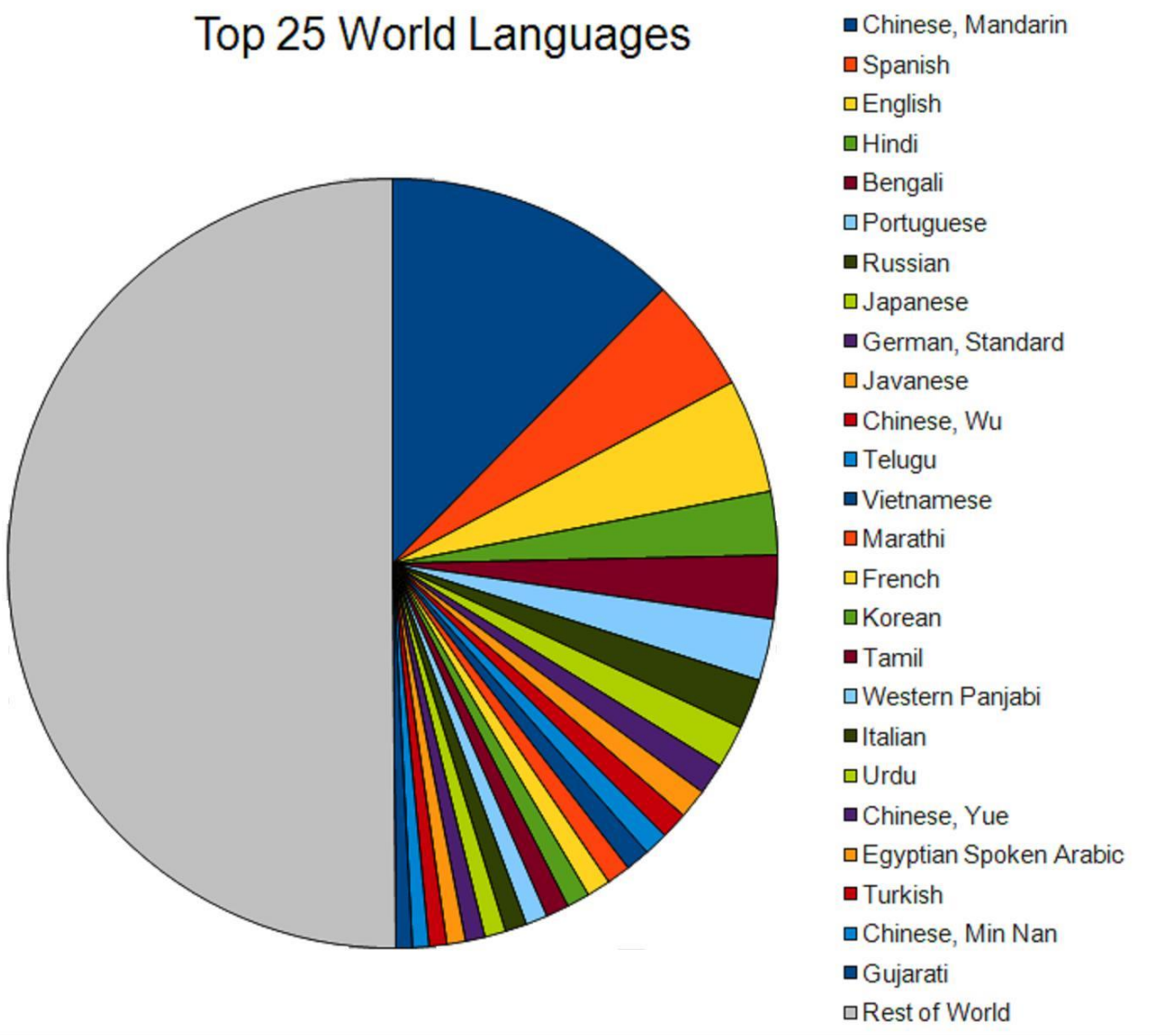
Top 25 World Languages
Chinese, Mandarin
Spanish
English
Hindi
Bengali
Portuguese
Russian
Japanese
German, Standard
Javanese
Chinese, Wu
Telugu
Vietnamese
Marathi
French
Korean
Tamil
Western Panjabi
Italian
Urdu
Chinese, Yue
Egyptian Spoken Arabic
Turkish
Chinese, Min Nan
Gujarati
Rest of World

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Dáág !
Au revoir !
左様なら
Pacim !
Selamat jalan !
До свидания!
안 녕

Miscommunication leads to mistakes

Miscommunicatie zorgt voor bouwfouten

Door Margreeth Fernhout
16 mei 2013 09:09 AM

De meeste constructiefouten worden gemaakt door slechte samenwerking en miscommunicatie. Dat blijkt uit grootschalig onderzoek onder bouwvakkers, door de TU Delft.

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Miscommunication can also lead to accidents

Fatal accidents in Construction in the US (CPWR)

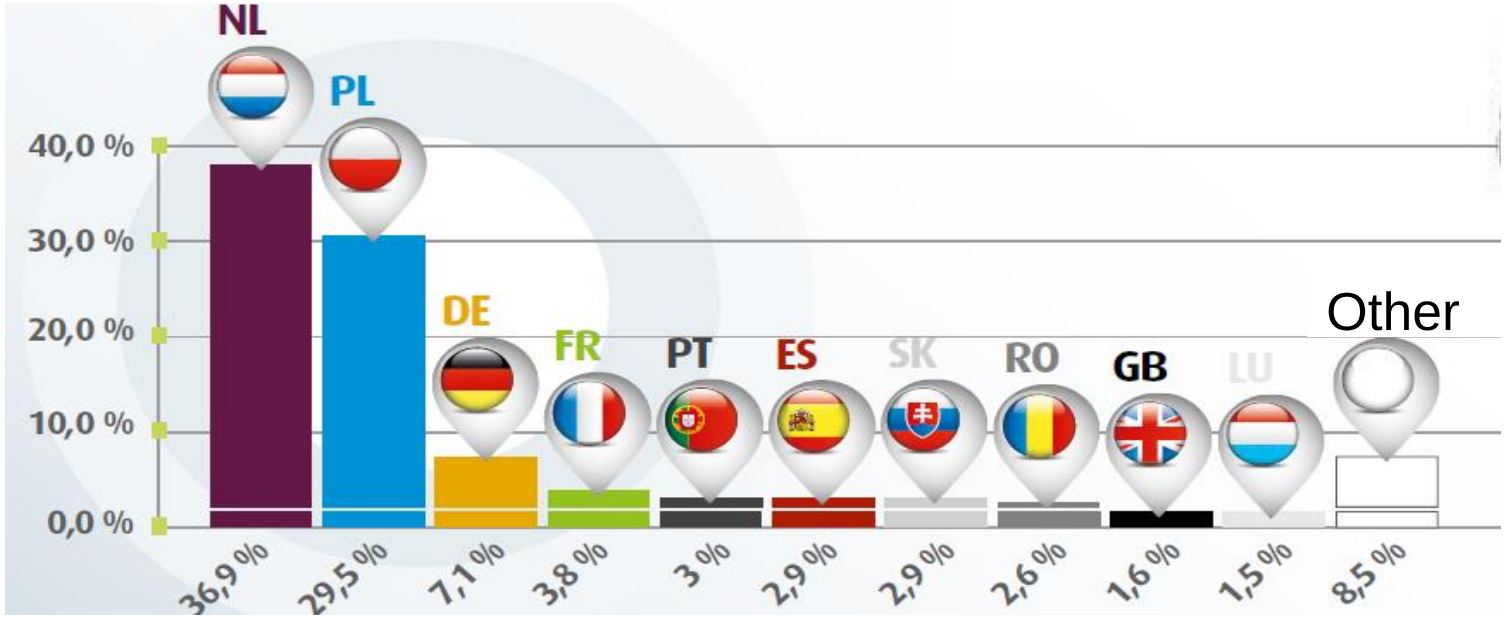
Migrant workers (Hispanic)	Proportion of fatal accidents	Year
6,5%	11,2%	1992
15%	23,5%	2000

Possible explanations

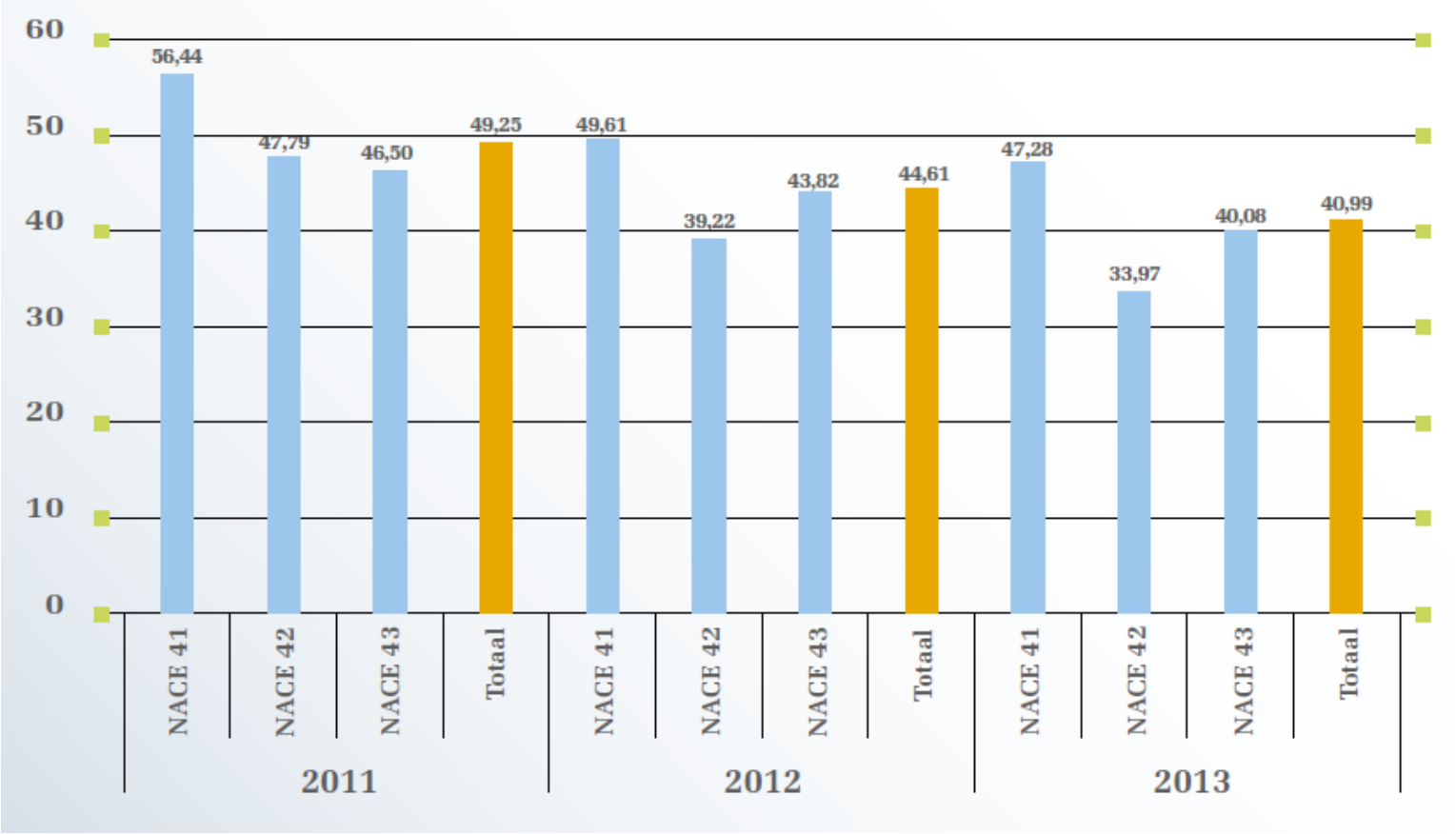
- …
- Less knowledge of English
- …

Story of the Belgian Construction Industry in 2014

- 151.061 blue collar workers on a Belgian pay roll
- 87,792 foreign workers



Accidents in the Belgian construction industry (Frequency Index)



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What about the accident figures for foreign workers?

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Observations made by *Navb-Cnac*

- Communication problems
  - Some workers do not speak the national languages, nor English
  - Therefore, safety instructions are not understood, Belgian regulations are not known
  - Communication with Belgian workers and site managers is complicated
- The taller the construction site, the more diverse it is

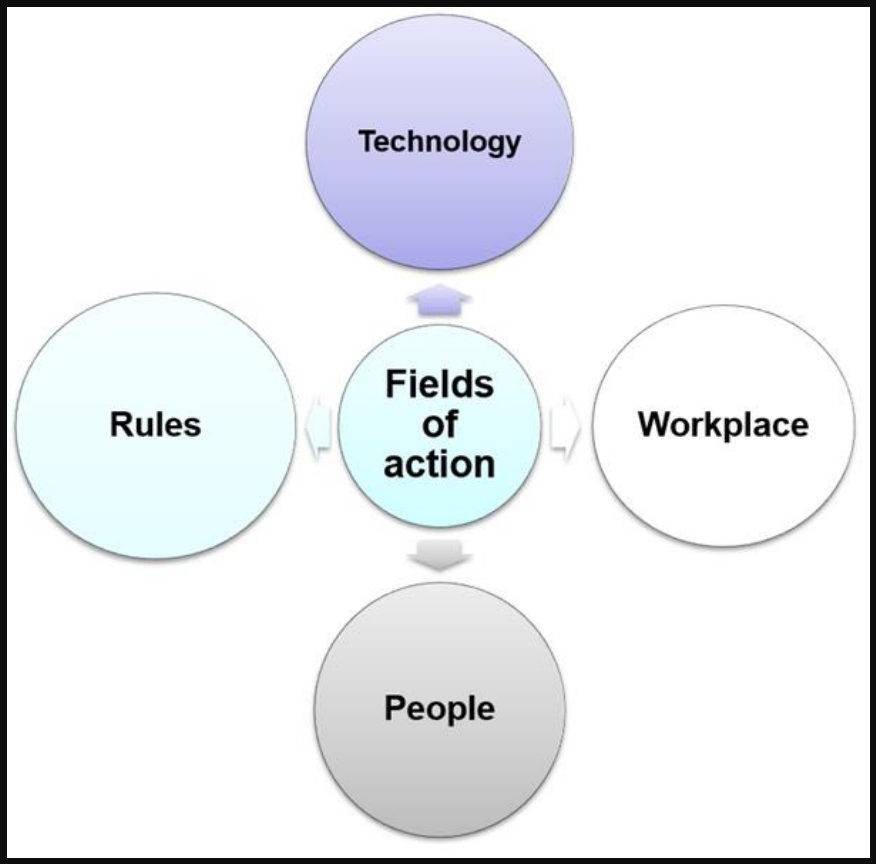
Recommendation 4

Be aware of

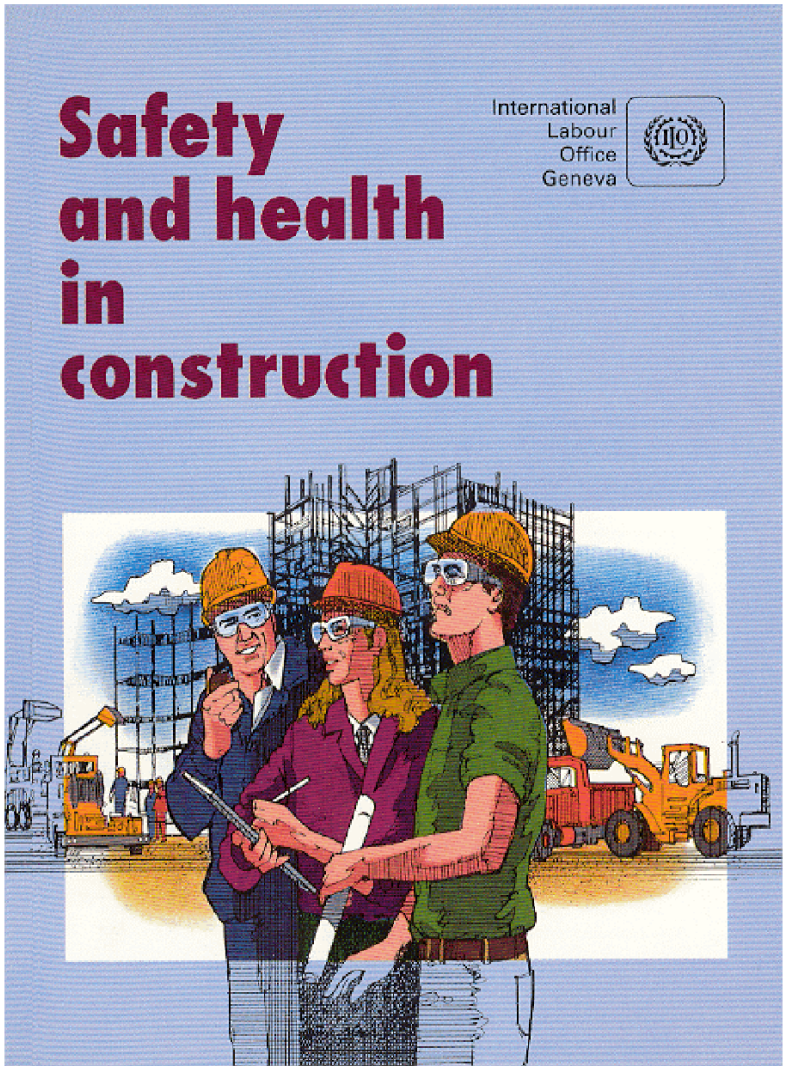
diversity

Managerial aspects

Management of Health and Safety: Fields of action



Referential book ILO



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Recommendation 5

Implement a strict management system for Health and Safety through all stages of the construction project


감사합니다
Natick
Grazie
Danke
Ευχαριστίες
Dalu
obrigado
Thank You
Köszönöm
Tack
Спасибо
Dank
Gracias
谢谢
Merci
Seé
ありがとう

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