Normet Norway AS

- Litt om hvem vi er og hva vi utvikler, produserer og selger
- Sement og betong og miljø
- En kort omvisning

Slomarka 11. februar 2019

www.normet.com

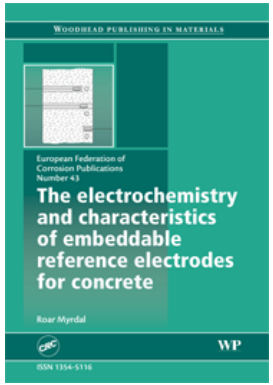
– Jeg har visst gjort noe liknende tidligere

Hvem er Roar Myrdal?

- Odøling, bor på Skarnes
- Kjemiker (doktorgrad fra UiO)
- 35 års erfaring innen FoU:
  - Forsvarets Forskningsinstitutt
  - Vegdirektoratet
  - FoU-sjef i Rescon Mapei fram til 2007
  - SINTEF Byggforsk (2007-2010)
  - Professor ved NTNU, Institutt for Konstruksjonsteknikk (20% stilling, fra 2004)
  - R&D Director Construction Chemicals i Normet International Ltd. (hovedstilling, fra 2010)

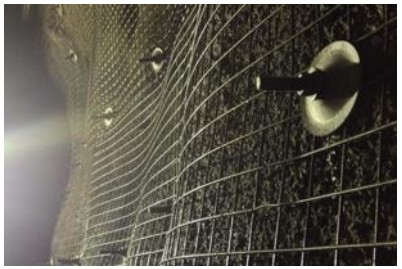
Vitenskapelig produksjon

- 45 internasjonale publikasjoner
- 1 bok
- 5 patenter
  - Tilsetningsstoffer for betong (3)
  - Sensorer for betongovervåkning (2)
- Ca 60 …
  - Tekniske rapporter
  - Foredragsmanuskripter
  - Undervisningskompendier



WE PROVIDE ADVANCED SOLUTIONS FOR SELECTED CUSTOMER PROCESSES IN UNDERGROUND MINING AND TUNNELLING



Normet's Customers

MINING COMPANIES AND CONTRACTORS

TUNNELLING CONTRACTORS

CIVIL CONTRACTORS

– Normet Expertice

MINING & TUNNELING

LATERAL & SHAFT GROUND SUPPORT
- Sprayed concrete
- Surface support liner
- Bolting
- Ground consolidation
- Scaling

EXPLOSIVES CHARGING

GROUNDWATER CONTROL

TUNNEL BORING MACHINE OPERATION

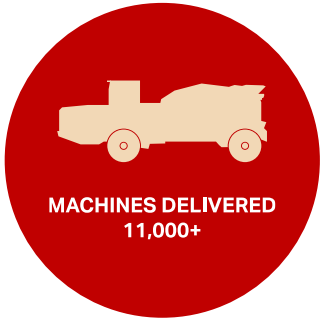
WATERPROOFING

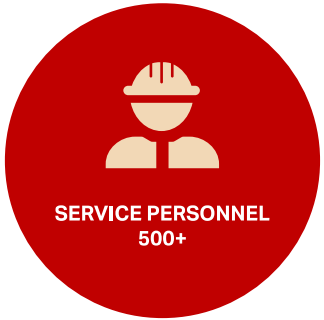
EQUIPMENT LIFE-CYCLE MANAGEMENT

SERVICES INSTALLATION

LINING

Normet i tall





Business lines

EQUIPMENT

- Concrete spraying
- Concrete transportation
- Charging
- Scaling
- Logistics
- Lifting and installations
- Used equipment

SERVICES

- Spare parts and consumables
- Scheduled and preventive maintenance
- Training and expertise services
- Rebuilds
- Field services
- Upgrades
- Rental services
- Service agreements
- Process solutions
- Sprayed concrete batching plants

GROUND CONTROL & CONSTRUCTION TECHNOLOGIES

CONSTRUCTION CHEMICALS

Concrete admixtures
- Sprayed concrete
- Precast concrete
- Cast-in-place concrete

Waterproofing
- Spray-on lining
- Leak sealing

Injection
- Water control
- Ground consolidation

Tunnel boring machinery
- Soil conditioning
- Tail shield sealant

Spray-on support liner

Mine backfill

ROCK REINFORCEMENT

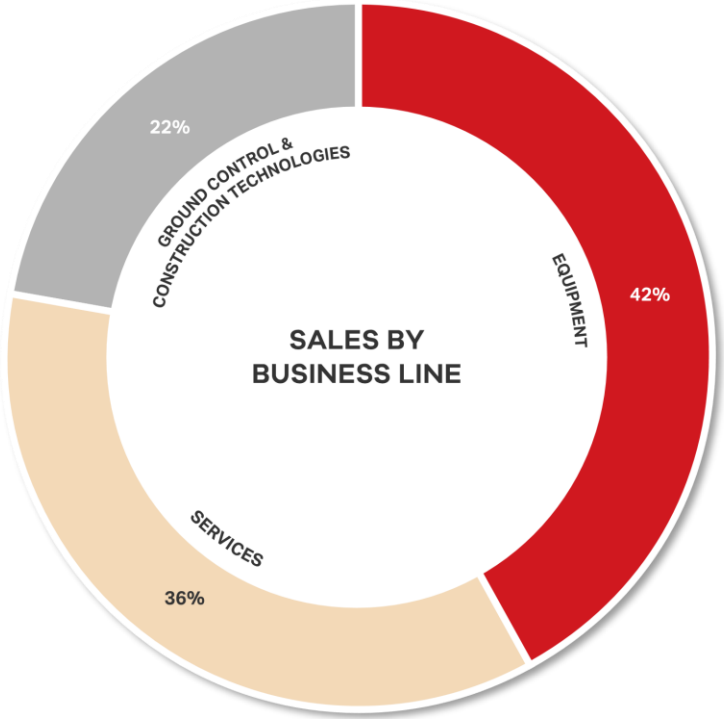
- D-Bolt® rock reinforcement element
- Self-Drilling Anchor system

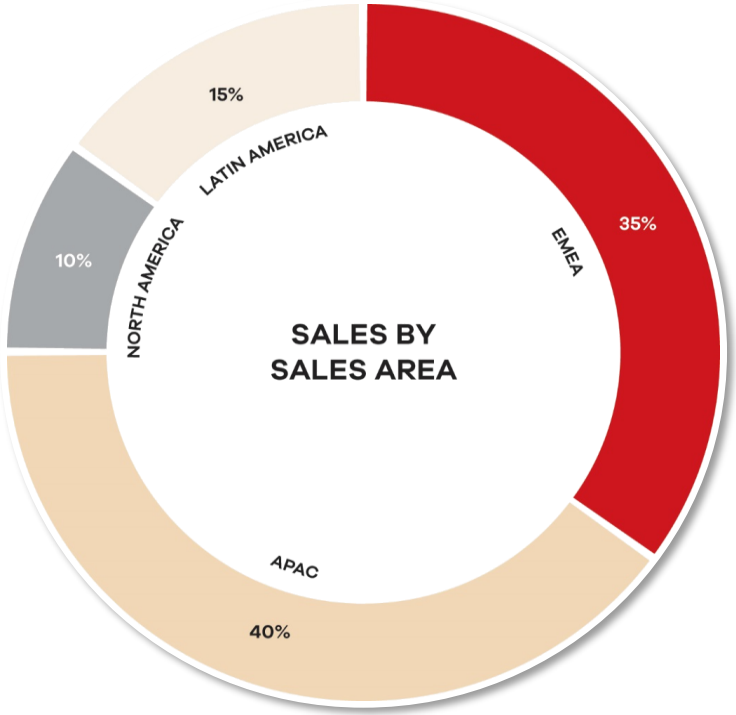
Maskiner og utstyr

CONCRETE SPRAYING	CONCRETE TRANSPORTATION	CHARGING	SCALING	UNDERGROUND LOGISTICS	LIFTING & INSTALLATION

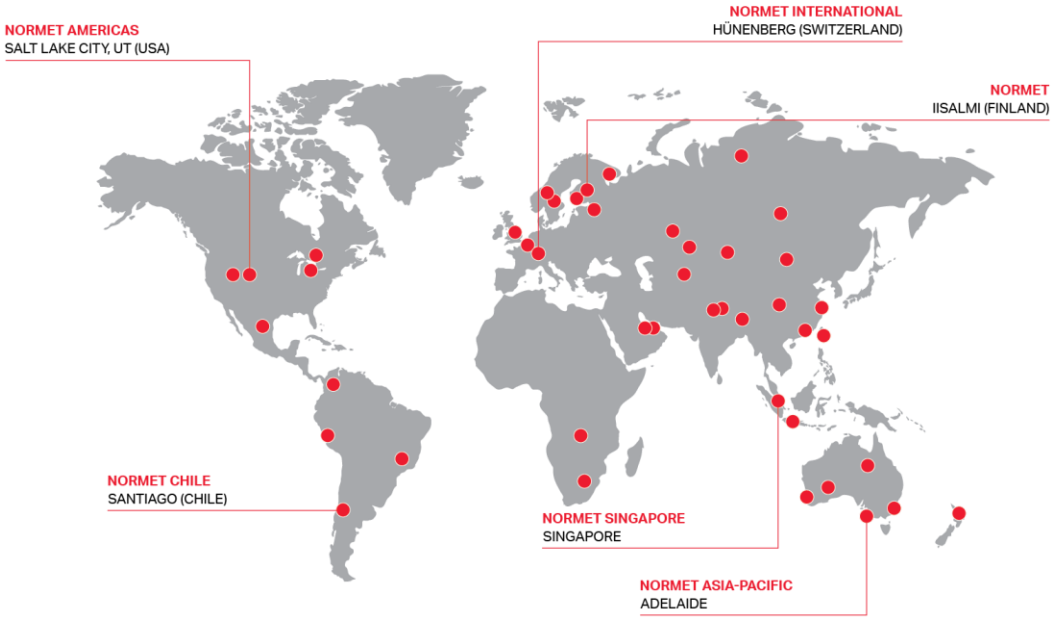
THE RIGHT EQUIPMENT FOR EVERY JOB

— Salg 2017


SALES BY
BUSINESS LINE
EQUIPMENT
42%
SERVICES
36%
GROUND CONTROL &
CONSTRUCTION TECHNOLOGIES
22%


SALES BY
SALES AREA
EMEA
35%
APAC
40%
NORTH AMERICA
10%
LATIN AMERICA
15%

Global tilstedeværelse



NORTH AMERICA
Canada
Mexico
USA

SOUTH AMERICA
Brazil
Chile
Colombia
Peru

EUROPE
Finland
France
Norway
Russia
Sweden
Switzerland
United Kingdom

AFRICA
South Africa
Zambia

ASIA
China
Hong Kong
India
Indonesia
Kazakhstan
Mongolia
Qatar
Russia
Singapore
Taiwan
United Arab Emirates
Uzbekistan

AUSTRALASIA
Australia
New Zealand

Normet etablerte seg på Skarnes i desember 2013

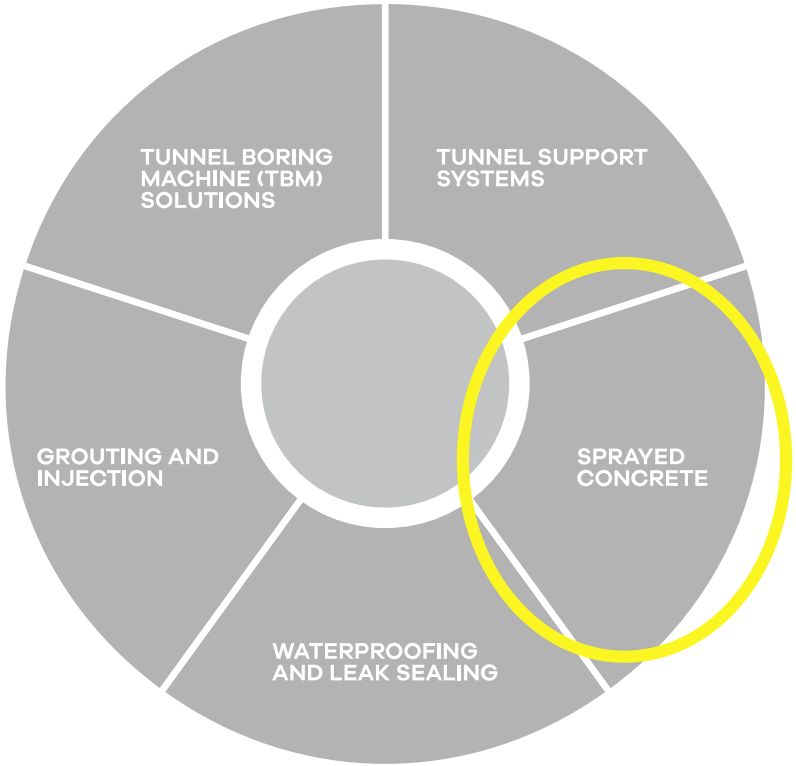
Salgskontor og lager
Silovegen 20

Flytter til Slomarka i 2016
Produksjon av Construction Chemicals

Construction Chemicals

A complete solution package based on over 30 years of experience, backed by reliable technical support.

Our solutions are appropriate from beginning to end – from ground treatment and construction of deep-box structures, through to tunnel or mine support and maintaining and extending the service life of underground structures.

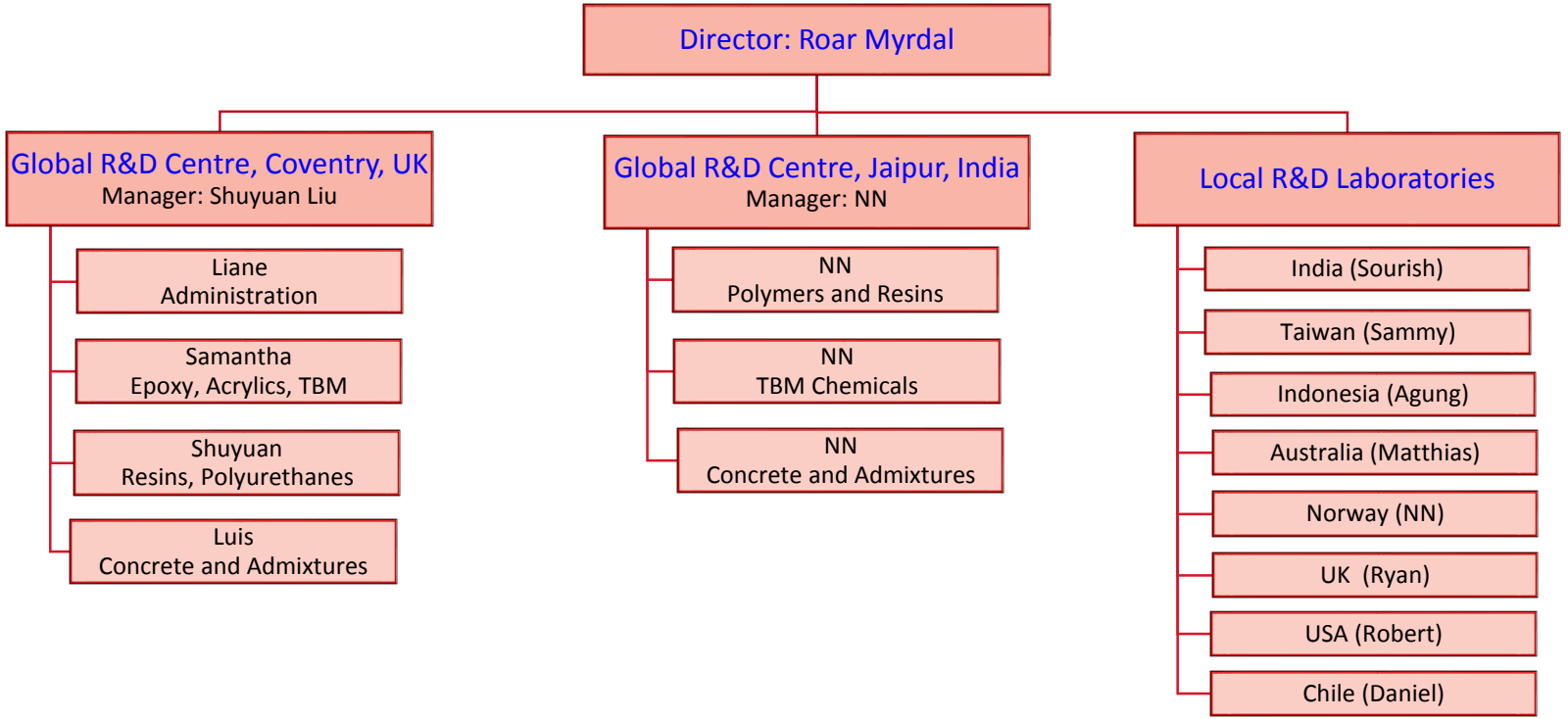


Research & Development (R&D)

- We partner with customers, universities, and suppliers to develop innovative solutions that meet our customers' needs
- Our R&D activities cover a wide range of construction chemicals
- We develop versatile, modular equipment platforms
- Our in-house competence is complemented by a world-class partner network

Professorn fra Skarnes tester tilsetningsstoff til sprøytebetong. Global R&D Centre, Coventry, UK

– Global R&D Construction Chemicals



Hva er Construction Chemicals?

- Kjemiske hjelpemidler som blir benyttet ved konstruksjonsarbeid for å gjøre utførelsen:
  - Enklere, raskere, billigere, eller rett og slett mulig
  - Og for å øke bestandigheten / levetiden til konstruksjonen
- De fleste produktene er i flytende form, noen i pulverform
- Kjemikaliene er ikke farlige, de fleste er like miljøvennlige som kjemikaliene vi drikker (Coca Cola og rødvin)

pH = 3,0

Varselord: *Fare*
Faresetning:
H314 Gir alvorlige etseskader på hud og øyne

pH = 2,8

Ikke merkepliktig!

pH = 3,3

Varselord: *Fare*
Faresetninger:
H315 Irriterer huden
H318 Gir alvorlig øyeskade

Construction Chemicals er så mye

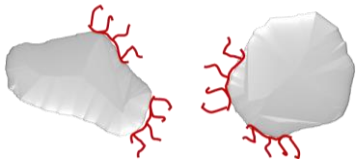
- Noen eksempler:
  - Injeksjonsmaterialer for vanntetting, jordstabilisering, etc.
  - Membraner, belegg, impregneringsmaterialer
  - Produkter for Tunnel Boring Machines (TBM's)
  - Tilsetningsstoffer for betong og sementbaserte produkter
- Normet utvikler alle typer pluss noen til!
- Normet har over 100 Construction Chemicals

Tilsetningsstoffer og hva de kan gjøre

- 3 eksempler:

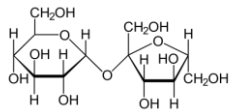
- Stoff som gjør betong flytende selv når mengden blandevann er liten (lite blandevann gir sterk betong, men 'tørr')

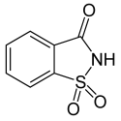
  Superplastiserende stoff



- Stoff som gjør at betongen ikke størkner før du vil at den skal størkne

  Retarderende stoff

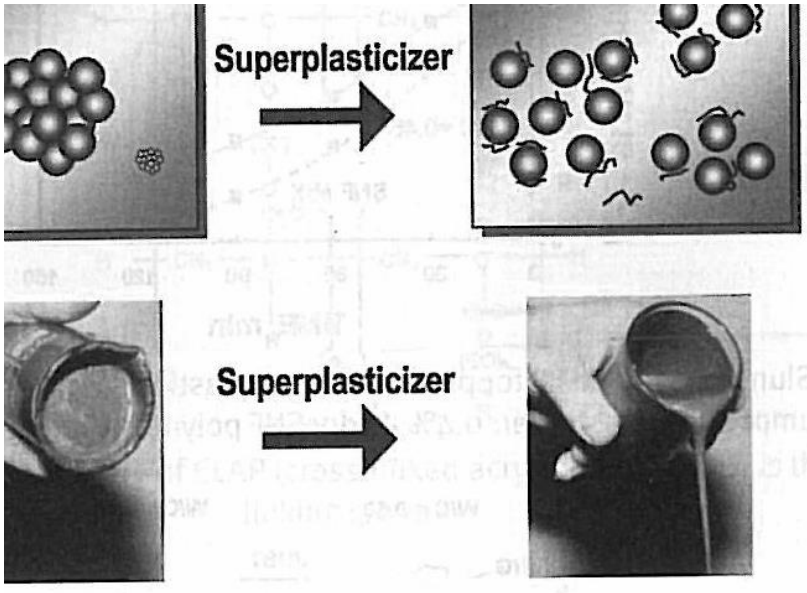




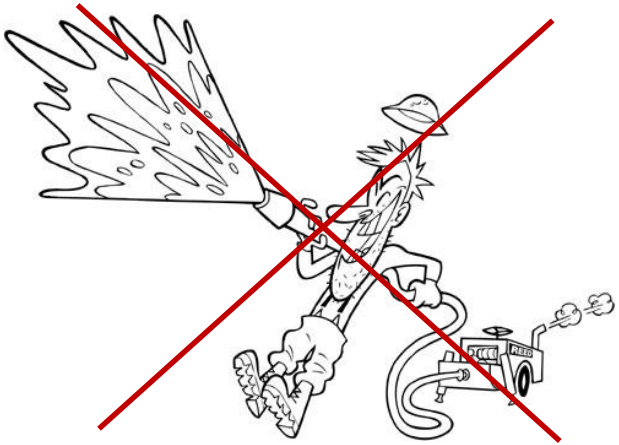
- Stoff som gjør at betongen bråstørkner og utvikler styrke svært raskt

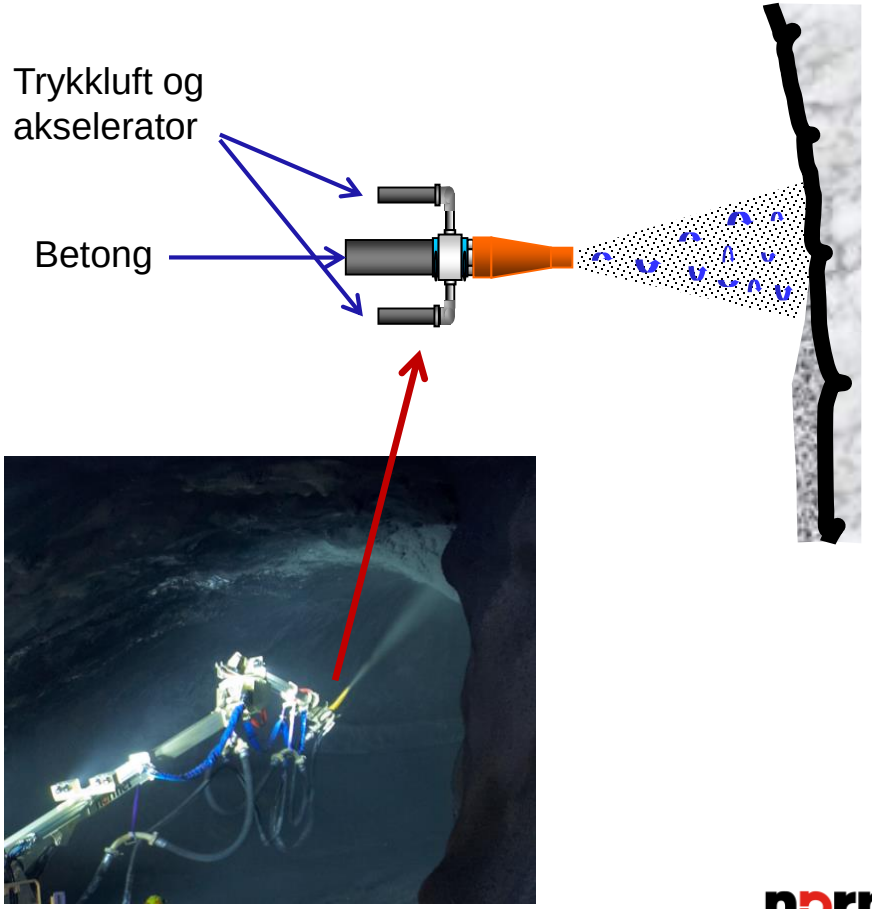
  Akselererende stoff til sprøytebetong

Superplastiserende stoff



Akselerator til sprøytebetong





Betong: Verdens mest brukte material

Typisk betongsammensetning
(Volumprosent)

Kjemiske tilsettingsstoffer 0,5-1%
Luft 4%
Sement 12%
Vann 18%
Sand 25%
Grus og stein 40%

Årlig globalt produksjonsvolum:

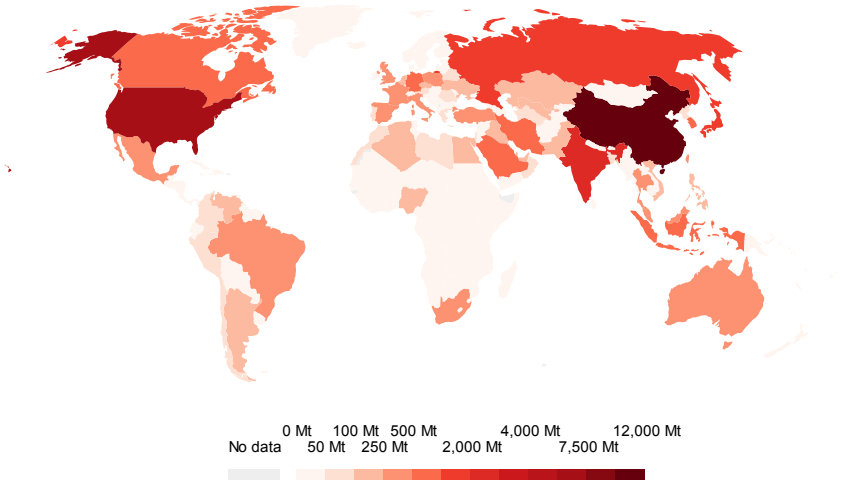
~10 km^3

10,000,000,000 m^3

Verdens menneskeskapte CO_2-utslipp 2016

Annual CO_2 emissions, 2016

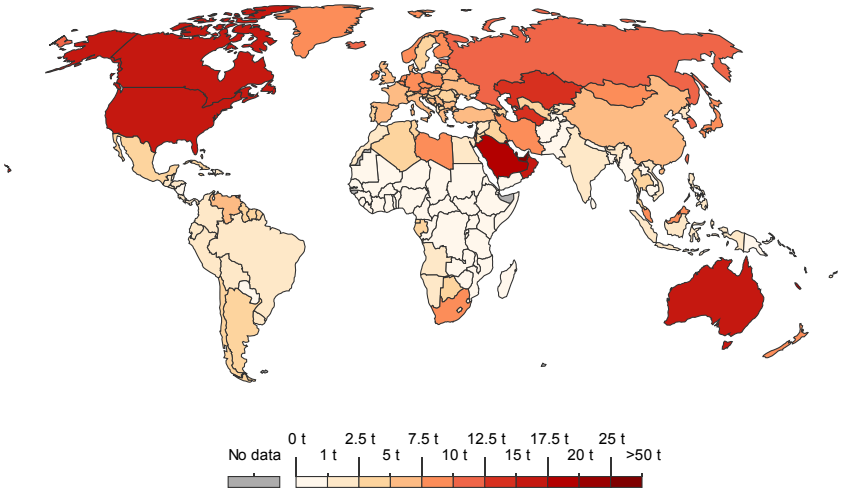
Annual carbon dioxide (CO_2) emissions, measured in million tonnes (Mt) per year.



Source: Global Carbon Project; Carbon Dioxide Information Analysis Centre (CDIAC)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY-SA

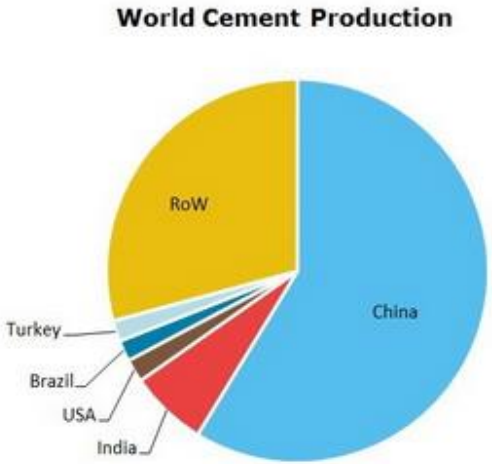
CO_2 emissions per capita, 2016

Average carbon dioxide (CO_2) emissions per capita measured in tonnes per year.

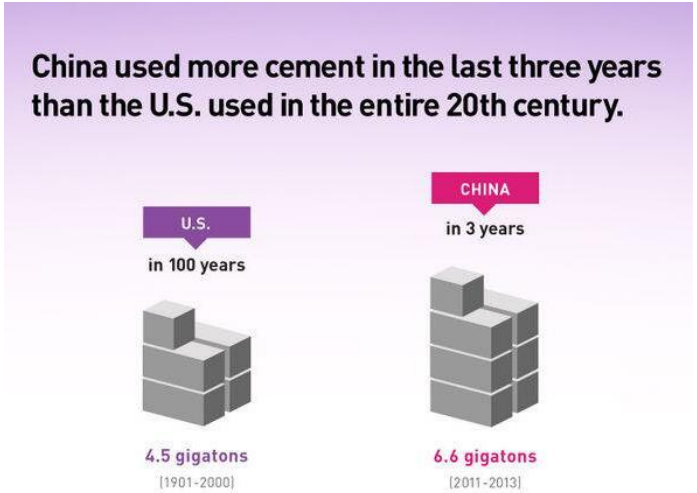


Source: OWID based on Global Carbon Project; Gapminder & UN OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY-SA

– Kina og resten av verden



https://mcgroup.co.uk/researches/cement



Washington Post, 24. mars 2015

Sement og CO_2

Kalkstein Brent kalk

Kalsinering (kalkstein): $CaCO_3 \rightarrow CaO + CO_2$ (60 %)

Fossilt brensel: $C + O_2 \rightarrow CO_2$ (40 %)

1 kg sement = 1 kg CO_2

Norcem i dag: 1 kg FA-sement = ca 0,7 kg CO_2

- Verdens sementfabrikker: Ca **8 %** av det globale menneskeskapte CO_2-utslippet
- Det er ca **2 ganger** CO_2-mengden fra verdens globale luftfart
- Derfor er "lavkarbon-sement" et viktig forskningsfelt
  - Blandingssementer (særlig med flygeaske), men også **betongbindemidler uten sement**

GEOPOLYMER: 70–90 % mindre CO_2-utslipp enn fra sementproduksjon

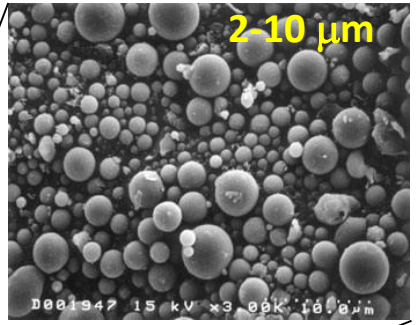
normet

Litt sementhistorie

- For veldig lenge siden: Romersk sement
  - Vitruvius (på Jesu tid)
  - Vulkansk aske + Kalk
  - Opus Ceamenticium, Pozzuolania
- For litt siden og nå: Moderne sement
  - Joseph Aspdin, engelsk oppfinner
  - Portlandsement (1824)
- Nå og nær framtid: Blandingssement
  - Norcem og andre sementprodusenter
  - Portlandsement + Flygeaske
- Litt lenger fram i tid: Geopolymer
  - Forskningsmiljøene
  - Aske + Litt kjemi, eller aller helst: **Leire** + litt kjemi

Isle of Portland

– Flygeaske fra kullfyrte kraftverk



NY Times 25.09.2011: *"China and India together are building four coal-fired power plants a week"*

Ash pond (lake), Suradevi, India, okt 2009

Hva er geopolymer?

- Grått pulver + Flytende komponent:

- Pulver:
  - Flygeaske
  - Kalsinert leire **FRAMTIDIG MULIGHET !**

- Flytende komponent
  - Sterk lut
  - Natriumsilikat (‘vannglass’)

- Problem: Trenger høy varme for å herde (60-80°C)
  - Derfor forsøkt i betongelement-industrien

  - Hva med herding ved romtemperatur?

Normet forsker på Geopolymer

- Laboratorieforsøk med flygeaske og kalsinert leire
  - Svært bestandig materiale
  - Tåler syre og brann; det gjør ikke sement
- Samarbeid med akademia
  - NTNU
  - University of Warwick, UK
- Materialet lar seg sprøyte (Normet, Taiwan, sommeren 2018)
  - Størkner raskt
  - Gir høy tidligstyrke (første minutter / timer) som vanlig sprøytebetong
  - Lav sluttstyrke (dager)

– Anerkjent fagtidsskrift omtaler Normet

Normet looks to greener cement alternatives

Globally, cement production accounts for around 5 percent of the world's carbon emissions. Around 900kg of CO_2 are emitted for every tonne of cement produced.

There are alternatives to Ordinary Portland Cement (OPC), however. Geopolymers, or alkali-activated binders, such as fly ash have benefits other than their environmental credentials: they can be used to produce mixes that are chemical- and fire-resistant.

There's one big problem, however, when it comes to using them in sprayed concrete. Mixes with alkali-activated binders usually require thermal curing and they are nasty to handle; the alkali silicate and highly concentrated alkali hydroxides which are caustic.

Roar Myrdal, Normet's R&D director for construction chemicals, has been interested in solving this problem since around 2014 when he became interested in geopolymers. "We wanted to find a user-friendly mix that is not very caustic and that sets at an ambient temperature," he says.

Such 'User-friendly' mixes have been created. In these, the aluminium caustic alkali hydroxide is removed and a calcium source such as slag or OPC is added. Unfortunately, such mixes don't retain the fire and chemical resistance that make geopolymer attractive for tunnel linings.

Normet's research started by testing a series of standard accelerators with geopolymer cement, none of which worked. And then, "by chance," according to Myrdal, the R&D team came across an organic liquid – a blend of organic compounds found in among polyols and esters – that reacted with the geopolymer mix, allowing it to set quite fast and develop a high initial strength. The pH of the resulting concrete was lower than that for standard concrete.

Researchers created a grout, mixing silica flour, fly ash, sodium silicate, water and 6 per cent by volume mass of fly ash and sprayed it onto a concrete substrate. Some of the results were encouraging: the grout set in less than sixty seconds and performed well once cured when exposed to fire via a propane torch.

But though the grout gained 1.5MPa strength after one hour, after 24 hours the strength had only reached 2.7MPa. "The one-day strength was awful," admits Myrdal. Later strength development was also slow.

A more fundamental problem with fly ash is that it isn't available in all parts of the world. In countries looking to reduce carbon emissions, coal-fired power stations are likely to become more and more rare. However, that isn't the case in developing economies such as India and China where fly ash is still plentiful.

However, Normet's research into fly ash has opened the door to investigation of another material: metakaolin, or calcined clay. Heating this clay up to 600 degrees for a few hours – which uses far less energy than cement production – produces calcined clay cement which is as reactive as the fly ash.

"We have already tested it and it works very well," says Myrdal. "It seems as good as fly ash and may even be better. The most interesting thing in the future for me would be clay."

Samarbeid med akademia

4/23/2014

THE EFFECTS OF SUPERPLASTICISERS ON THE WORKABILITY OF FLY ASH GEOPOLYMER CONCRETE

THE UNIVERSITY OF WARWICK

ES327 Individual Project

Third Year School of Engineering
University of Warwick

Sponsored by: normet FOR TOUGH JOBS, TAM Global Construction Chemicals

Author: Vivienne Yeung (1114385)

NTNU
Norwegian University of Science and Technology

Mechanical Properties and Durability Aspects of Alkali-activated Fly Ash Mortars With and Without Addition of Blast Furnace Slag

Eivind Rø Jevne

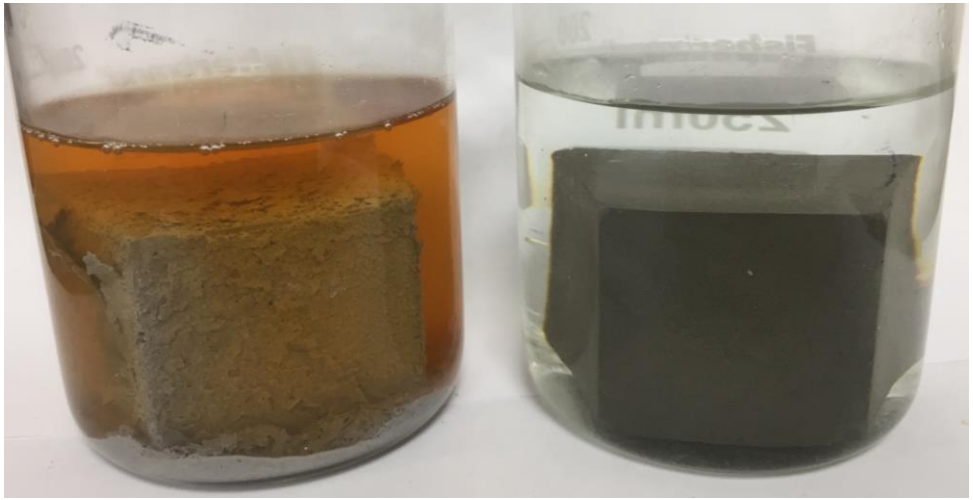
Civil and Environmental Engineering
Submission date: February 2018
Supervisor: Roar Myrdal, KT

Norwegian University of Science and Technology
Department of Structural Engineering

normet

Kjemisk bestandighet

Små herda terninger etter 2 dager i 10% svovelsyre



Sement Aske (med 'lurium' fra Normet)

Roar Myrdal and David Galloway: "*Accelerating Admixture for Fly Ash / Sodium Silicate Binders Cured at Ambient Temperature*", paper presented at 11th High Performance Concrete & 2nd Concrete Innovation Conference, Tromsö, Norway, 6-8 March 2017, Conference Proceedings, Paper No. 59, 8 pages.

Brannbestandighet (~1300°C i 2 minutter)

Geopolymer (aske), uskadd

Sement eksponert for samme varme resulterte i eksplosiv avskalling

Kanskje verdens første sprøyting av 'askemørtel'

Material	Vekt-%
Fin silikasand	34,4
Flygeaske	34,4
Natriumsilikat-løsning	24,5
Vann	6,9
Totalt:	100,0
+ Normet's herdeakselerator	Dosering ca 5% av askemengden Tilsettes i munnstykket

Roar Myrdal and Sammy Tong: *"Sprayed Concrete without Portland Cement"*, paper presented at 8th International Symposium on Sprayed Concrete – Modern Use of Wet Mix Sprayed Concrete for Underground Support, Trondheim, Norway, 11-14 June 2018, Conference Proceedings (ISBN: 978-82-8208-060-6), pp 244-251.

Taiwan i juni 2018