

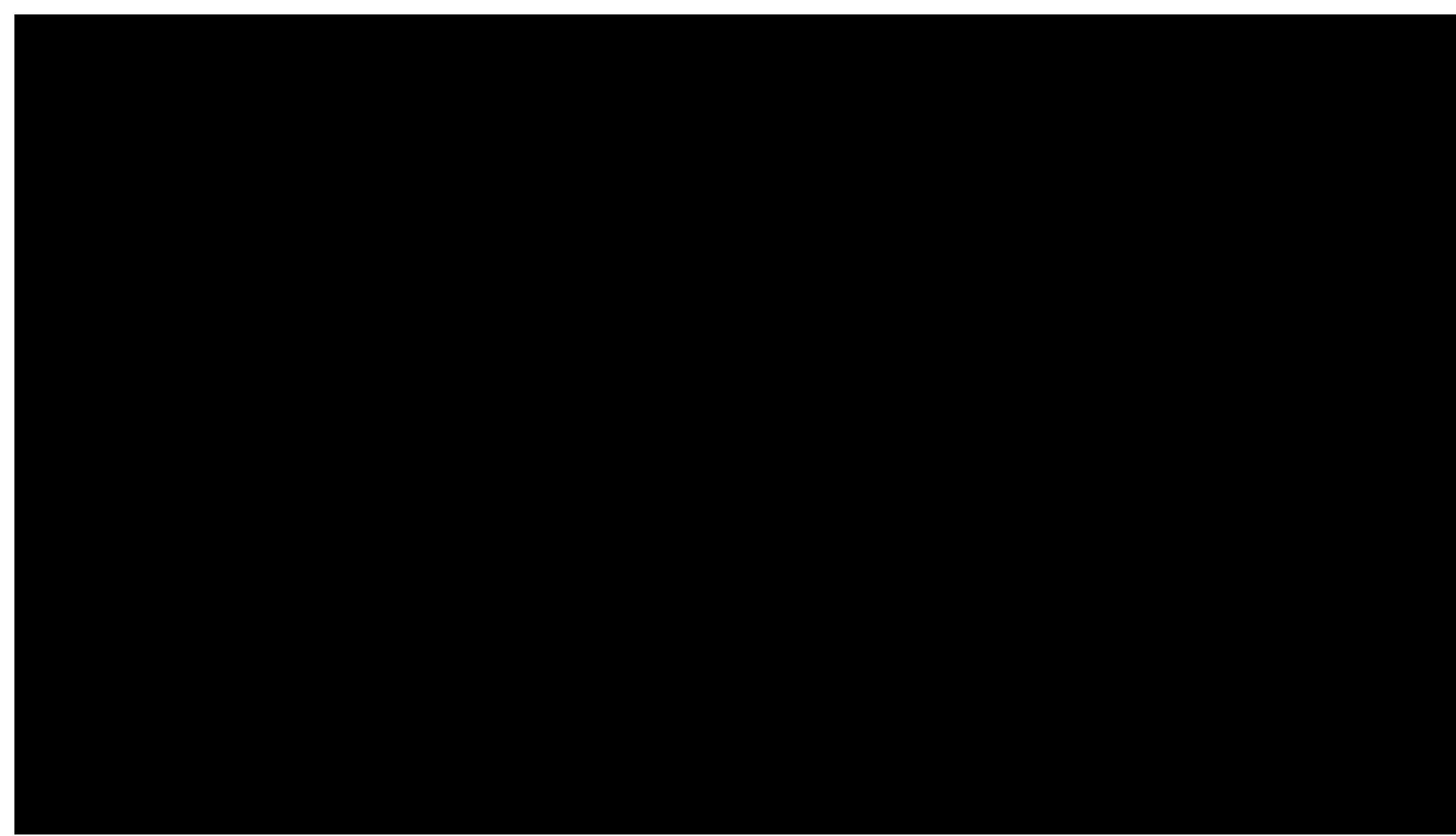
'Transformation towards a sustainable built environment' The importance of the role of the Building Regulator in the South African Building Sector

2018 BCO Annual Convention

Date: 22nd November 2018:

Location: 158 Loveday street, Braamfontein, Johannesburg

Joe Odhiambo



Vision & Mandate

➤ Vision

To-be World Class Technical Assessment Agency.

➤ Mandate

Agrément South Africa is mandated by the Minister of Public Works to “support and promote the process of integrated socio-economic development in South Africa as it relates to the building and construction industry by facilitating the introduction, application and utilisation of satisfactory innovation and technology development”.

Demystify infrastructure delivery & improve infrastructure delivery.

Agrément does not build houses but facilitates innovation.

It certifies “fit for purpose” technologies.

Code of Hammurabi 1754 BC

If a **builder builds a house for someone**, and **does not construct it properly**, and the house which he built falls in and **kills its owner**, then the **builder shall be put to death**.....,

.

If the owner's son dies,.....

If the owner's wife dies,.....

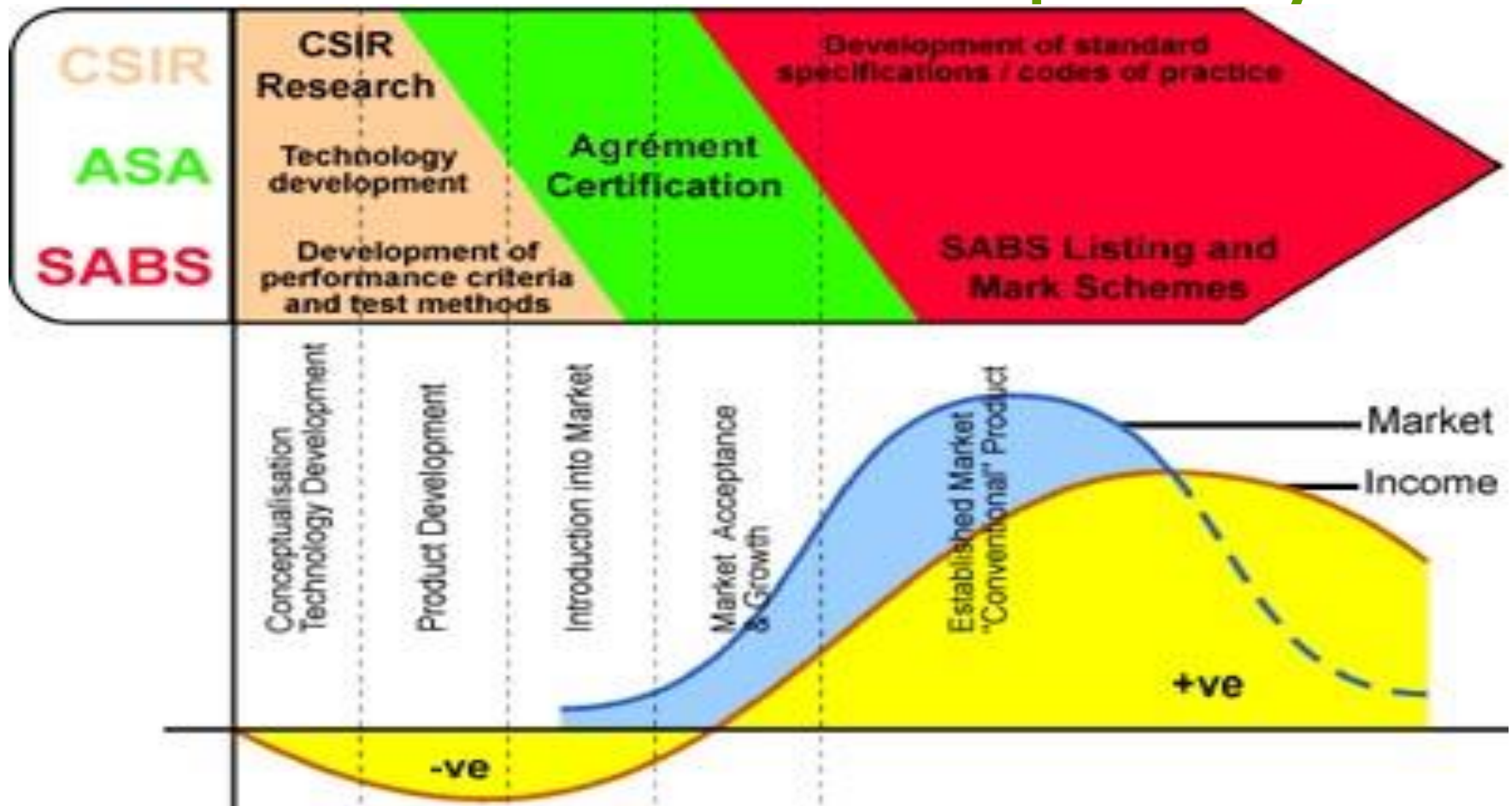
Advocates **An eye for an eye, and a tooth for a tooth.**" This phrase, along with the idea of written laws, goes back to ancient Mesopotamian culture.

Importance of following the regulations

Everyone therefore who hears these words of mine, and does them, I will liken him to a wise man, who built his house on a rock. The rain came down, the floods came, and the winds blew, and beat on that house; and it didn't fall, for it was **founded on the rock**. Everyone who hears these words of mine, and doesn't do them, will be like **a foolish man, who built his house on the sand**. The rain came down, the floods came, and the winds blew, and beat on that house; and it fell—and great was its fall.

— Matthew 7:24–27, World English Bible.

Product Development Cycle



BUILT ENV. PROFESSIONALS

**Building Act
2004**

**Building Regulations
Schedule 1 (Building Code)**

Objective

**Functional
requirement**

Performance

**Acceptable Solutions
and
Verification Methods**

Alternative Solutions

DEEMED TO COMPLY

ALTERNATIVE METHODS

- Product certification [CodeMark]
- Determinations
- Cited documents

Other methods to demonstrate compliance:

- In-service history
- Expert opinion – e.g. producer statements
- Comparison to Acceptable Solutions, Verification Methods and other documents
- Comparison to previously approved Alternative Solutions

Cited standards

Standards

Trends in Construction

HOW

TECHNOLOGY

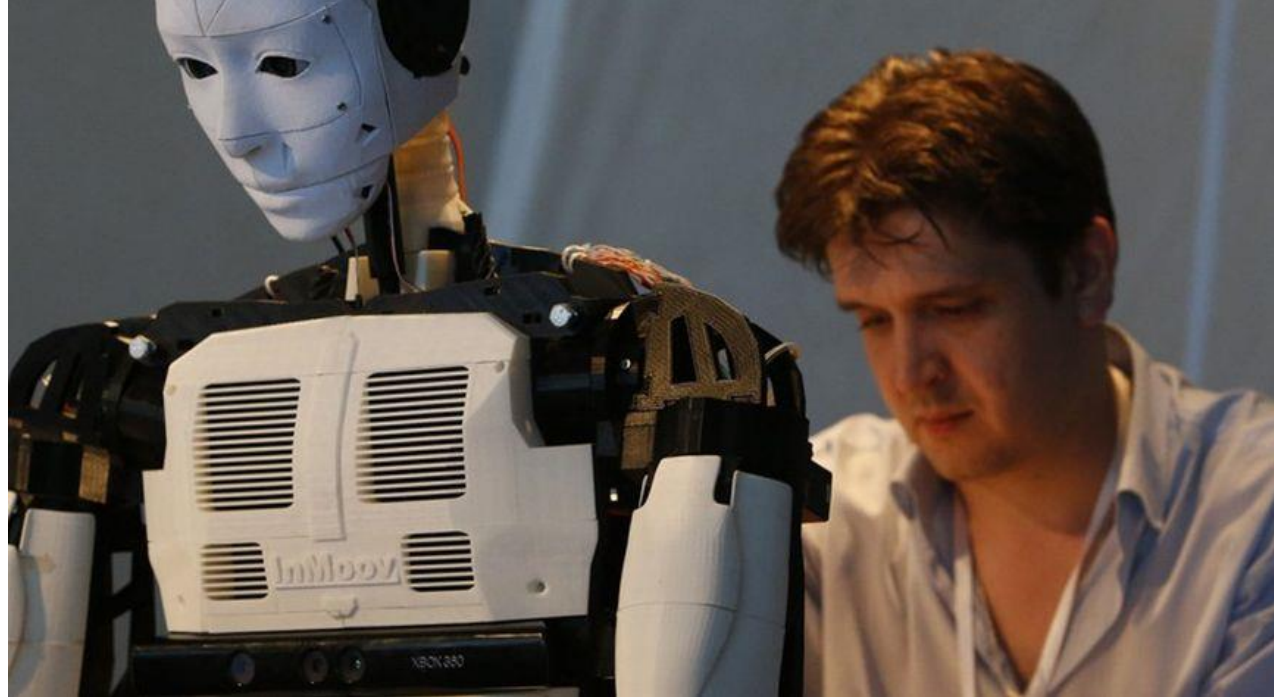
IS CHANGING THE

CONSTRUCTION INDUSTRY



4th Industrial Revolution

Fourth Industrial Revolution will have brought us advanced robotics and autonomous transport, artificial intelligence and machine learning, advanced materials, biotechnology and genomics



- Design modelling software
- Use of drones
- 3D printing
- Construction building Apps
- Communication systems eg satellite
- Green Technology

Global Trends & Challenges

➤ Global trends

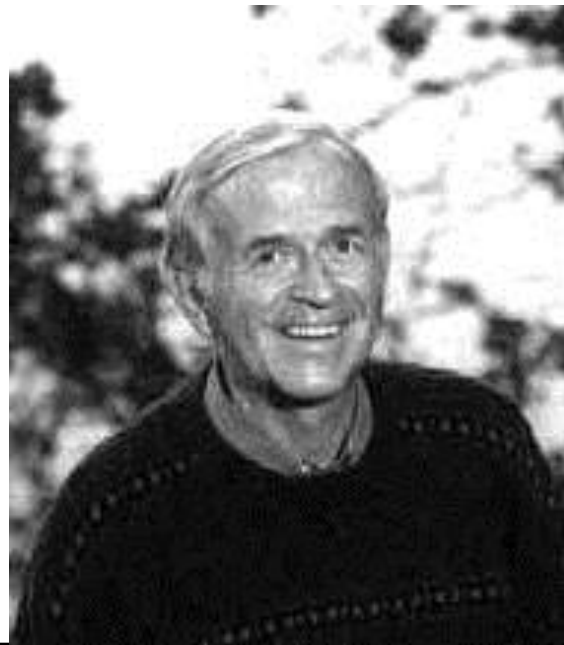
- Population increase.
- Globalisation.
- Urbanisation.
- Climate Change.
- Technology Advances.



➤ Transport Challenges:

- Increasing demand for a more efficient, effective, integrated and safer transport environment.
- Pressure to deliver and maintain transport infrastructure and service levels to match a growing demand.
- Greening of transport and concerns about impact of Climate Change.





“The problem is never how to get new,
innovative thoughts into your mind,
BUT.... *how to get the old
ones out.*”

Dee Hock, founder of Visa







Machine Learning



Deep Learning



Artificial Intelligence



broad sustainable building



Browse

Upl

30-Story Building Built In 15 Days (Time Lapse)

MrBeeblebroxx



Subscribe

45 videos







**SKY CITY:
220
STORY
BUILDING IN
90 DAYS**

SKY CITY ONE

Tall planned skyscraper in the city of Changsha, Hunan in south-central China.

The prospective builders, Broad Sustainable Building, estimated it would take just 90 days to construct, but this is not counting 120 days of prefabrication before on-site work commences; the total schedule is 210 days/





➤ **220 Floors**

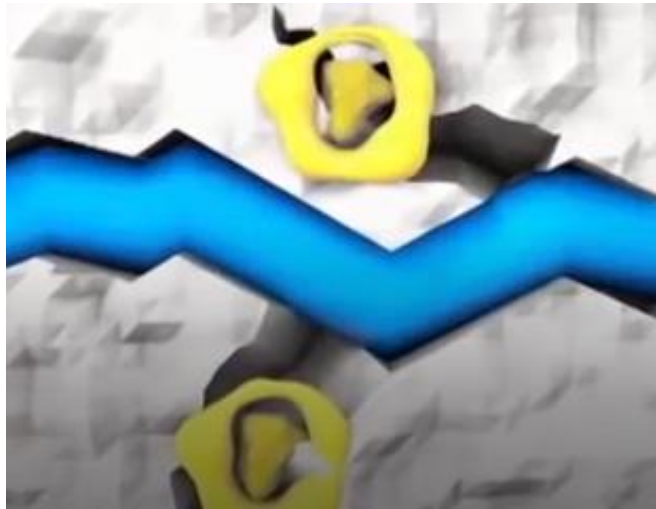
➤ **838 Meters**

➤ **Energy-efficient**

➤ **Earthquake-resistant**

➤ ***90 days !***







2030 Predictions

- 65% of children starting school in 2018 will enter jobs that don't exist yet
- 65% of children now at school will have 14 different jobs before age 40
- Workforce will need a 'basket of skills' for flexible career paths in multiple career changes across occupational fields
- The amount of technical information is doubling every 2 years
- 60% of what students learn in their 1st year at university is outdated by their 3rd year
- 80% of the technology we will be using in 2030 hasn't been conceptualised yet

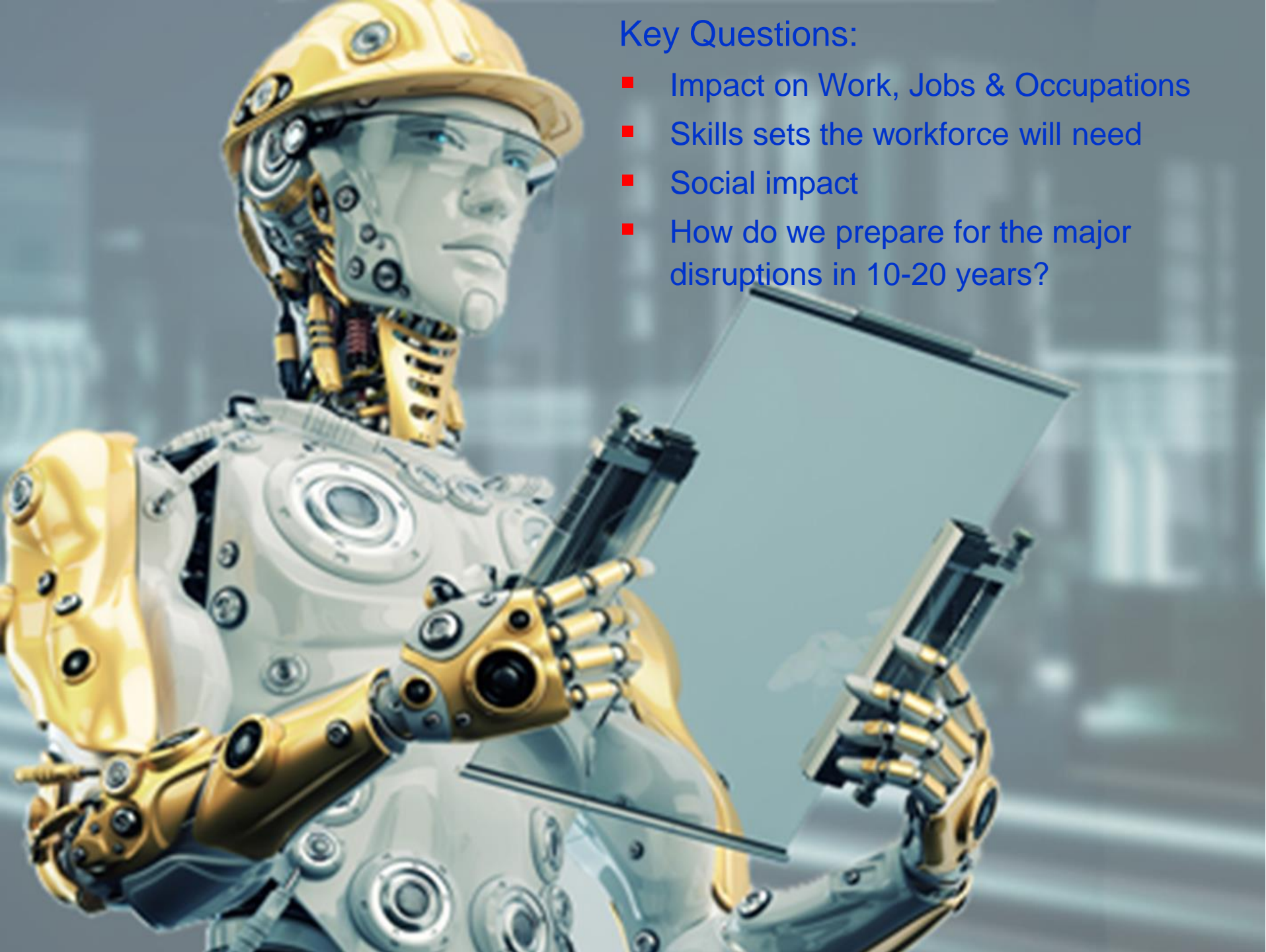
*“We are currently preparing students for jobs that don’t yet exist,
To be using technologies that haven’t been invented,
In order to solve problems we don’t even know are problems yet.”*

(Video: Did You Know? / Shift Happens, David Rose)

***“We are still preparing students for the market that
prevailed fifty years ago, educating students for the
job market of the middle of the last century.”***

(Clem Sunter)





Key Questions:

- Impact on Work, Jobs & Occupations
- Skills sets the workforce will need
- Social impact
- How do we prepare for the major disruptions in 10-20 years?

Trends & developments

Public sector increases its innovation capacity and capability by:

- sharpening the government structures.
- that support innovation, strengthening leadership.
- smoothening relationships with local citizens.
- acknowledge the uniqueness of each beneficiary location.
- keep at heart the Beneficiaries-First Principles.
- open themselves up to learning and adopt new innovative models.
- discontinue outdated policies and approaches.
- ensure that the culture of routinisation and path dependency is terminated.

Research Findings.

- limited capacities at local level to implement innovative services delivery through cost-effective measures.
- lack of technical capacity in municipalities, dedicated persons to champion and drive innovation.
- challenges in terms of integration of technology and innovation in the delivery of basic services and municipal business processes.
- lack of adequate innovation enabling policy instruments.
- lack of access to appropriate and validated innovative technology solutions by municipalities.

building control officer

- "**building control officer**" means any person appointed or deemed to be appointed 'as building control officer
- by a local authority in terms of section 5; (iii) ·

building control officer

- 5; (1). Subject to the provisions of subsection (3) a local authority shall appoint a person as building control officer in order to exercise and perform the powers, duties or activities granted or assigned to a building control officer by or under this Act.
- (2) Any person not having the qualifications prescribed by national building regulation in respect of a building control officer shall not without the approval in writing of the Minister be appointed as building control officer in terms of subsection (1).

building standards enforcement

Standards equate societal norms and values of what is acceptable and what is not.

- structural stability and safety
- Fire: focus on entire management,
- health and safety
- Condensation and moisture penetration
- humidity
- Human comfort
- Human safety
- accessibility and usability
- Constructability

Do building control officials have enough teeth?

Reasons for failures

- Poor or wrong designs
- Failure to comply with minimum standards
- Poor planning
- Poor or ineffective constructability studies
- lack of legislative compliance.
- Ineffective management and supervision on construction sites
- Failure to submit plans for all approvals
- Lack of design coordination amongst professionals
- Use of poor standard materials
- Lack of sufficiently skilled, experienced and knowledgeable persons to manage construction sites.
- Corruption

Endless reasons but the key reason it is easy to get away with it so people do not take it seriously

Resilient Built Environment

- There is a need to reverse the growing trend construction site accidents, building failures, collapses etc which result in unfortunate injuries and avoidable death.
- **Solution is to regulate the profession.**
- **Professionalization**
- Aim is to ensure that there are adequate controls, evaluation and constant monitoring of the levels of compliance by the construction and related industries with Construction Health and Safety issues.





Sampong Department Store Location: Korea 1995 side 33

Initially conceived as a four-floor office building, the chairman of the property called for changes during construction that would allow the building to function as a large department store instead. Several support columns were cut away in order to install elevators and the building's air conditioning unit was moved to the roof, creating a load four times the design limit. Moreover, the owner added a fifth floor despite warnings of imminent collapse. In 1995, five years after it was completed, all of the building's columns in the south wing gave way, trapping more than 1,500 shoppers and killing 502 people in a mere 20 seconds.



Seongsu Bridge Location: Seoul, South Korea Year of Fail: 1994

Spanning the Han River, this 3,800 foot-long bridge was completed in 1979 and collapsed in 1994 due to improper welding of the steel trusses under the concrete slab roadway. 32 people died and 17 were injured when one of the slabs broke off and went crashing into the water below.











SO
CLOSE...



FOR THE
C
LIVE













Tongaat Mall collapsed, killing two people and injuring 29 others.





Conclusion

BCO's are the public referees



#Poor buildings standards Must fall

Examples of Building Systems

Tilt up Concrete

Building's walls are poured directly at the jobsite in large slabs of concrete called "tilt-up panels" or "tiltwall panels". These panels are then raised into position around the building's perimeter forming the exterior walls.

Tilt up Concrete

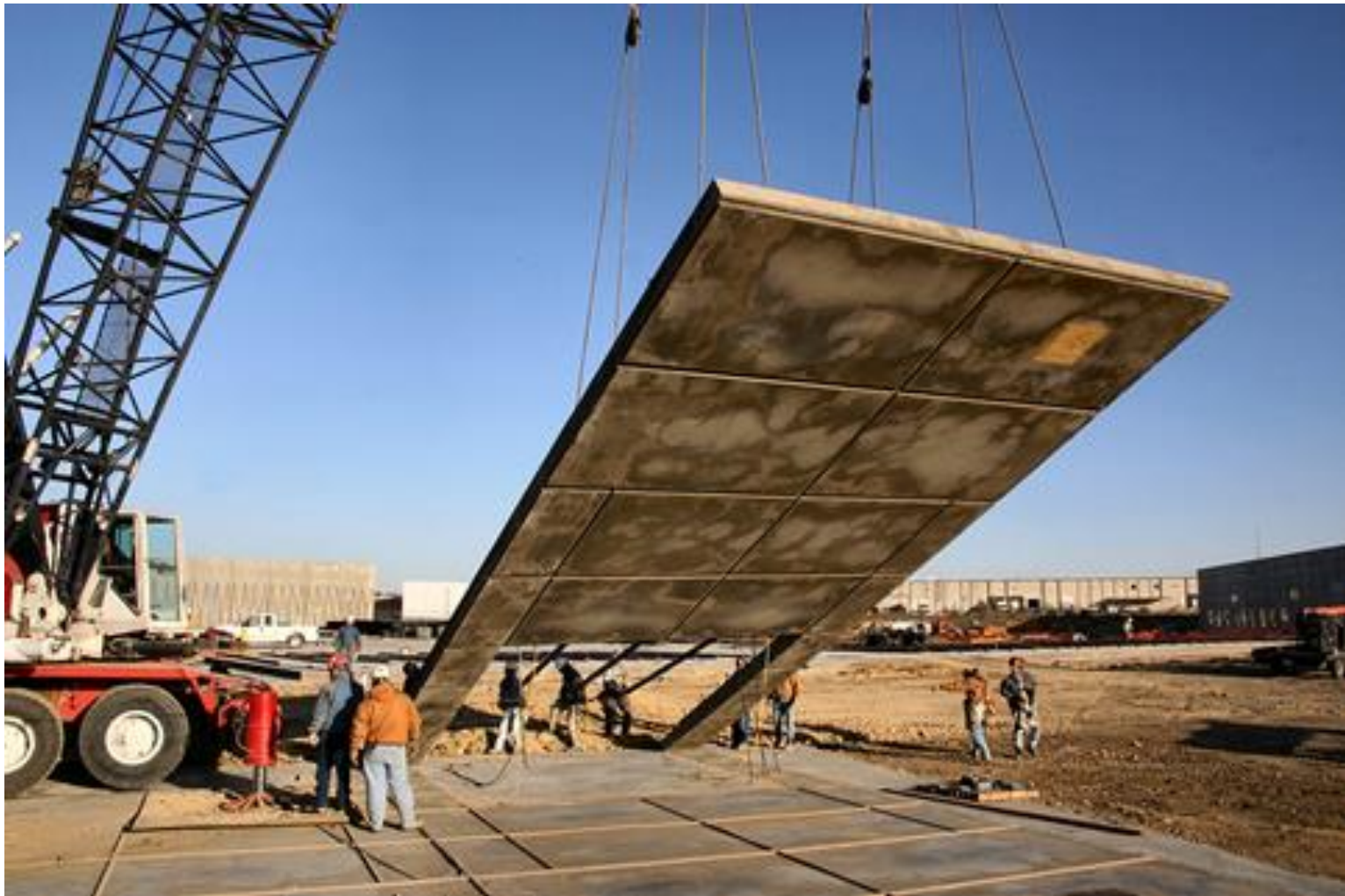
Load-Bearing Walls.

- The Tilt-Up industry is reaching new heights with the record lifts. They greatly reduce on-site labour requirements compared with conventional brick and mortar.









Hydraform Building System



Better From The Ground Up



Rambrick is an innovative smart brick made from compressed earth and recycled rubble waste. Pioneered by Use-it, a building sector NGO, Rambrick is committed to offering you a high-quality, cost-effective and environmentally friendly building solution. The brick is Agrément Certified, SABS compliant and 3 times stronger than hollow concrete blocks. Use-it is CIDB and NHBRC registered; Africa's first 5-star EcoStandard rated eco brick is truly better from the ground up.

What you get when you build with the smarter brick:

Quality

- 5% cement stabilised brick
- Strength of 9 MPa to 14 MPa
- Unique bonding (slurry vs mortar)
- Unique but conventional building system

Water saving

- Dry manufacturing process
- Low water usage

Cement usage

- Low cement content while still maintaining strength
- Minimal cement used for building (slurry vs mortar)

Thermal properties

- Thermally efficient structure
- Low heat transfer rate
- High R-value

Structural integrity

- Fireproof
- Bulletproof
- Earthquake-resistant
- Load bearing
- Water-, insect- and mould-resistant

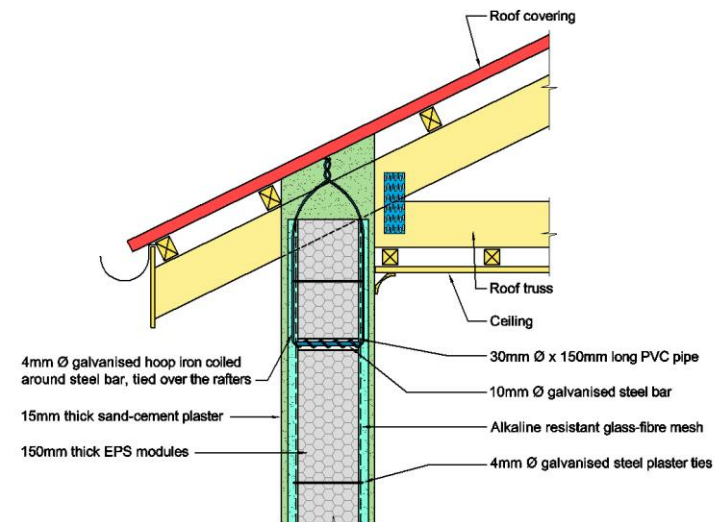
T : 031 765 2349
www.use-it.co.za
www.rambrick.co.za



T : 031 765 2349
www.use-it.co.za
www.rambrick.co.za

Mega Building System

- The walls comprise interlocking expanded polystyrene (EPS) core which act as permanent insulation.
- The EPS core for external walls is 2400 mm x 1200 mm x 150 mm thick and finished with one layer of 25 mm thick glass-fibre reinforced concrete (GFRC) and 15 mm thick sand-cement plaster, both sides.



Ikhaya Building system



Ground floor wall panels comprise two cores of **40mm thick EPS with a density of 16kg/m³**, spaced **120mm** apart forming a cavity that is filled with **(reinforced) concrete**.

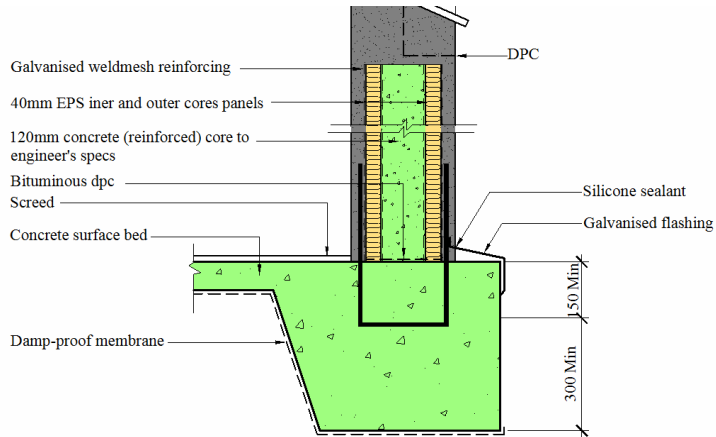
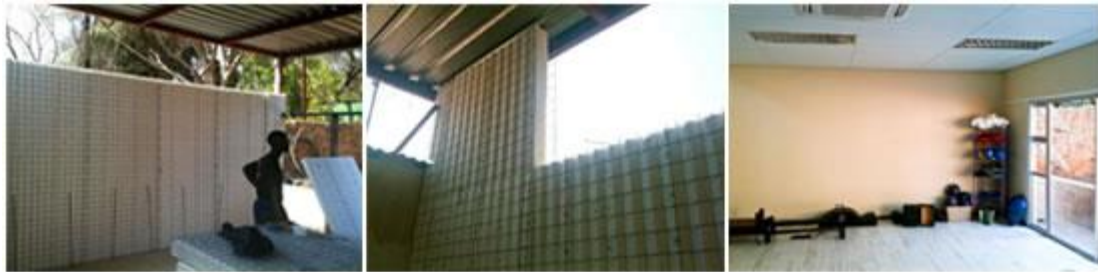
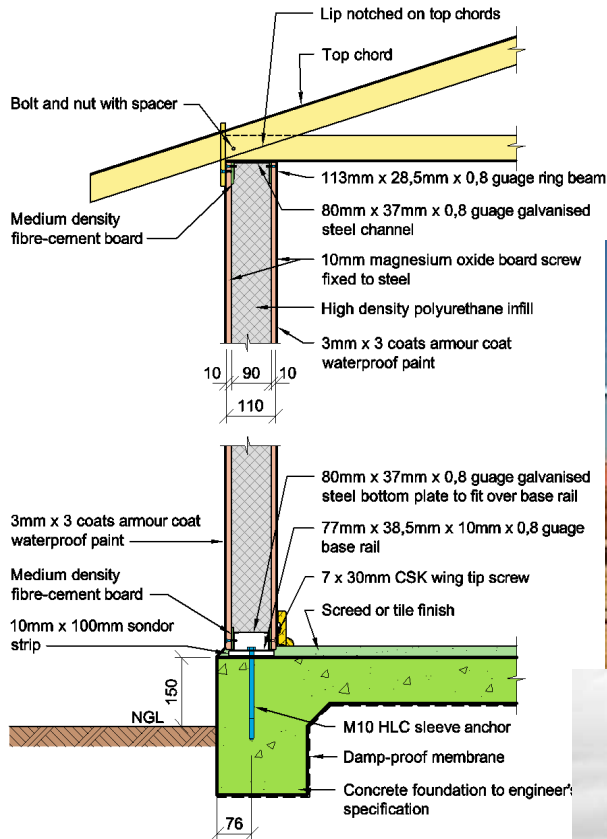


Figure 1: Ground floor external wall section



Vela Steel Building System

The development is home to 288 beneficiaries and is the first phase of the Delft Integrated Housing Project. The total construction cost for Roosendal housing development was R38.7 million.

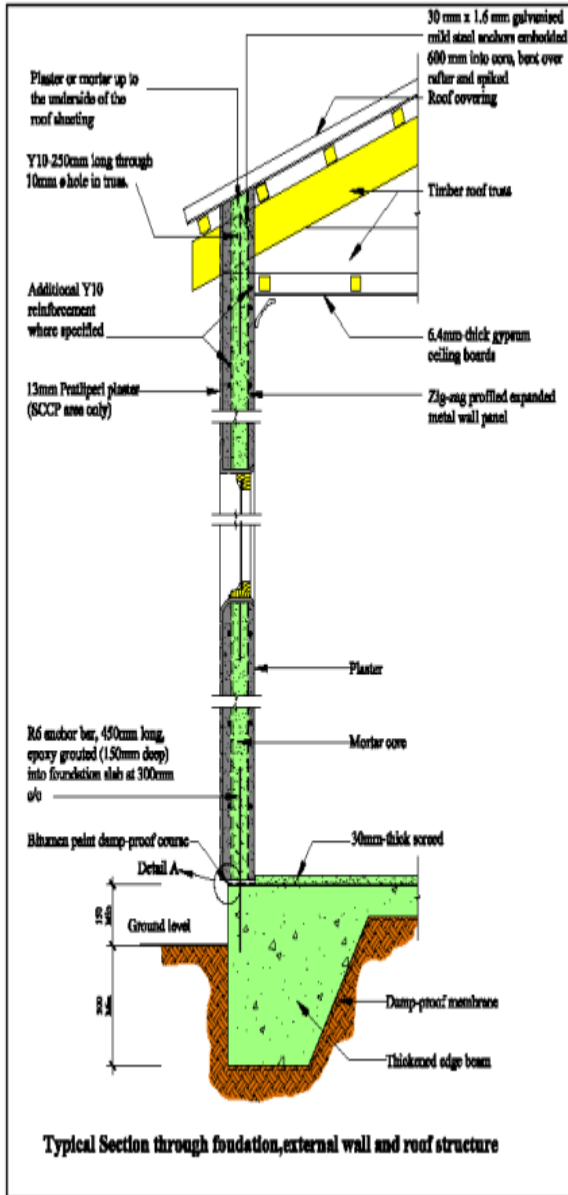


Aruba 2000 Building system

Aruba Eco Building Systems specialize in **Insulated Concrete Form (IFC) construction, using Expanded Polystyrene (EPS) modules. Flame – retardant expanded polystyrene (EPS)** in building construction in Europe over the past four decades. A fast, cost effective building system that would suit local conditions, comply with all statutory requirements and facilitate the use of unskilled labour.

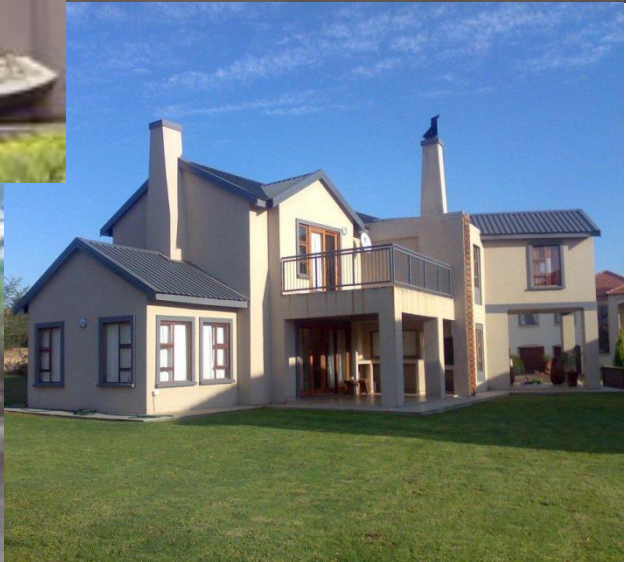
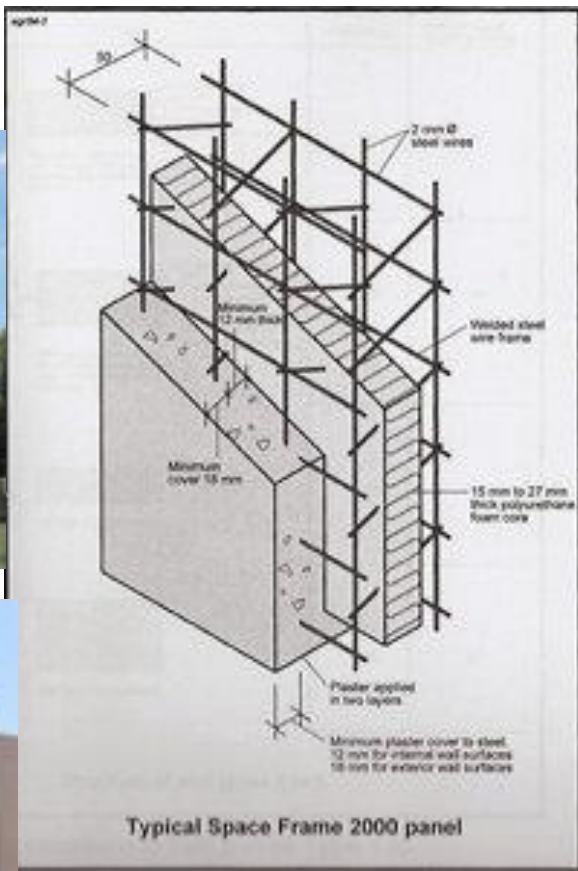


Robust Building system



Spaceframe 2000 Building system

- Spaceframe is a building system consisting of 3-dimensional welded wire panels with polyurethane insulation.
- Panels are made up of a 50mm wide lightweight frame of 2mm mild steel wire and can be supplied with or without the 15mm polyurethane insulation.
- 130kg per square metre (plastered).



To improve quality of life and comfort for people

> Inside view after plasterboard, painting & floor finishing



Copyright © ArcelorMittal

7

Some pictures of the site in Newcastle



Copyright © ArcelorMittal

Confidential

16

Performing the aesthetic aspect

> Outside view of Standard Protea House (40m²)



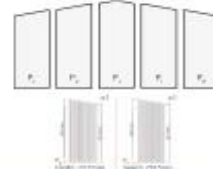
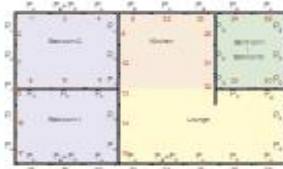
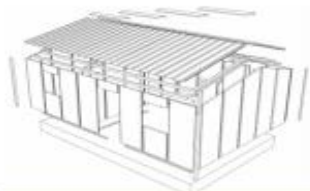
Off-Site Engineering & Prefabrication

> Manufacturing process

1. Drawing, Engineering

Modularization of drawing

Industrialisation of drawing



2. Prefabrication, Packaging



Sandwich Polyurethane panels

3. Full Delivery on Site



Including:

- Wall & Roof panels
- Flashings
- Accessories
- Connection kit
- Waterproofness kit
- Weight: ~ 2.3 Tons

Confidential

Innovative building technologies (IBTs)

- Centre of Excellence.
- Enabling environment.
- Construction products & systems.





Examples of Roads Products



With technology “evolving at breakneck speed”, drivers are in “for some really interesting changes”. The biggest of these changes will be the move to the [driverless car](#), or autonomous driving, as it is also called, enabled by a host of vehicle sensors, [radar systems](#) and cameras.

Working towards a zero-accident environment!



Smart Roads / Forever Open Roads

Adaptable Road Element		
Innovation theme	Innovation in design	Innovation in delivery
Innovation topics	Modular design	Prefabrication methods
	Low energy consumption pavements	Low carbon materials and components
	Climate resilient infrastructure	New materials in pavements, bridges, tunnels and structures
	Safe roads: self-explaining and forgiving infrastructure	Asset management toolbox and performance standards
	In-built and wireless sensors	Automated inspection and survey methods
	Long-life pavements	Low cost and rapid maintenance methods



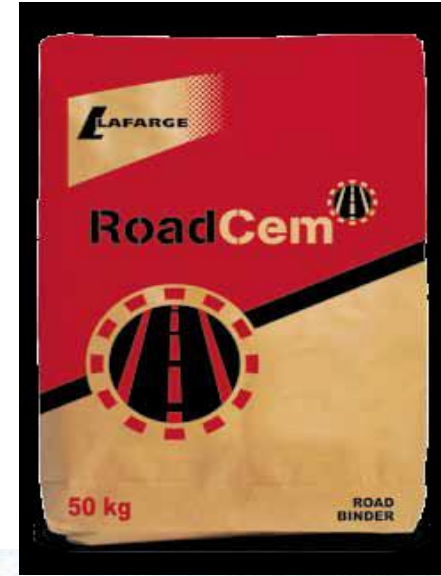
Roadcem non-traditional soil stabiliser

- ROADCEM is a brand name for a product consisting of earth-alkaloids and zeolites which is used in conjunction with **cement for road based stabilization.**
- It reacts with cement and bond in-situ soil to form a water resistant, elastic and high strength composite material.



Benefits

- Highly durable product.
- Results in a high quality sub-base.
- Efficient utilisation of resources (Materials).
- Leaching potential is significantly reduced.
- Can be installed by unskilled workers.
- Job creation potential.



RAKTEL 8010

Universal Traffic Event Logger

Counter, Classifier, Weigh In Motion

- ◆ Reliable permanent traffic monitoring
 - ◆ Multi sensor input
 - Loop only
 - Loop plus axle and/or WIM sensor
 - Axle sensor only
 - ◆ Flexible sensor configurations
 - ◆ High performance cross-talk free digital loop detector
 - ◆ Interfaces for all the popular axle sensors
 - Piezo cable
 - Piezo strip
 - Fibre optic
 - ◆ Interfaces for all popular HSWIM sensors
 - Bending plate
 - Piezo
 - Piezo quartz
- RAKTEL 8010 is a major upgrade from the RAKTEL 8000
- Increased loop sensitivity
 - Improved piezo axle detection
 - Enhanced classification
 - New power management
- Modular design, card frame allowing flexible configuration
 - Active lightning protection
 - Digital chassis height detection
 - Comprehensive system & sensor performance monitoring
 - Anti-coincidence detection
 - Tidal flow and reverse direction recording
 - User friendly set-up and complete diagnostics
 - Video frame grab control
 - Range of most popular classification algorithms
 - Provision for all popular data formats
 - User modifiable parameter sets
 - Complete software support
 - Supports serial, TCP/IP, GSM & GPRS communications
 - Low power consumption
 - Solar charging
 - Hot swappable batteries
 - Offscale sensing
 - Overheight detection



Mikros Systems



Your Partner in Traffic Engineering

High Speed Weigh In Motion

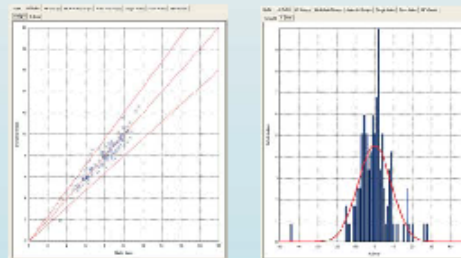
From Mikros Systems

◆ By using the Mikros Systems RAKTEL as basic platform the following list of attributes and features are standard:

- Modular Design
- High performance cross-talk free loop detection
- Digital chassis height detection
- Comprehensive system & sensor performance monitor
- Anti-coincidence detection
- Tidal flow & reverse direction recording
- Video frame grab control
- Overheight detection
- Range of most popular classification & data formats
- User modifiable parameter sets
- Complete software support
- Complete range of communication interfacing
- Low power consumption
- Solar power charging
- Hot swappable batteries
- Offscale sensors

◆ Protocols available to integrate into weigh station control software

Calibration



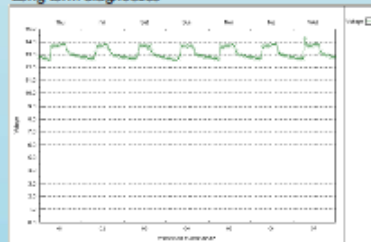
Automatic calibration results and verification of applicable standard (ASTM & COST323)



Output from the calibration module providing video confirmation of calibration vehicles used at both the HSWIM and reference scales

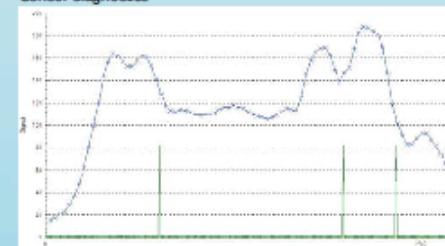
Diagnostics

Long term diagnostics



Long term battery voltage information

Sensor diagnostics



Vehicle profile & axle information

Mikros Systems 
Your Partner in Traffic Engineering

Mikros Systems (Pty) Ltd
PO Box 75034
Lynnwood Ridge, 0040
South Africa

Tel : +27 (0)86 111-5393
Fax : +27 (0)12 804-4706
Mail : mikros@mikros.co.za
Web : www.mikros.co.za

syntel
A Syntel group company

Concrete Products

Translucent Concrete

Many new technologies are changing the way we build and what we build with concrete.

- Adding optical fibres to a concrete mix generates translucent concrete. This “see-through” development is changing the perception of concrete’s opaque mass.



(Source Americas Cement Manufacturers)

Aesthetic concretes

Aesthetics concretes offer many advantages:

Excellent **adaptation to complex shapes**.

Quick installation and low maintenance.

Resistance to wear and tear.

Creative freedom with a wide choice of colours and surface appearances.



Artevia®



Computerized precision colour control Concrete

Computerized precision colour control are revolutionizing the precast industry.

- Emerging panels are being manufactured with Carbon Cast, a grid of carbon fibre reinforcing. The resulting weight reduction generates savings in shipping, erection, and substructure costs.



(Source Americas Cement Manufacturers)

High-performance concrete (HPC)

Conforms to a set of standards above those of the most common applications, but not limited to strength. While all high-strength concrete is also high-performance, not all high-performance concrete is high-strength. Some examples of such standards currently used in relation to HPC are:

Ease of placement. Compaction without segregation.

Early age strength. Long-term mechanical properties.

Permeability. Long life in severe environments.

Heat of hydration. Toughness.

Volume stability. Density.

Environmental.



High Performance Concrete



Unit-IV



Ultra-high-performance concrete

UHPC is characterized by being a steel fibre-reinforced cement composite material with compressive strengths in excess of 150 MPa, up to and possibly exceeding 250 Mpa. UHPC is also characterized by its constituent material make-up: typically fine-grained sand, silica fume, small steel fibres, and special blends of high-strength Portland cement.

Note that there is no large aggregate. The current types in production (Ductal, Taktl, etc.) differ from normal concrete in compression by their strain hardening, followed by sudden brittle failure. Ongoing research into UHPC failure via tensile and shear failure is being conducted by multiple government agencies and universities around the world.



Ultra-high performance concrete (UHPC)

ultra-high performance: its strength is 6 to 8 times greater than that of conventional concrete.

fiber-reinforced: it contains metal fibres that make it **ductile**. With a structural strength 10 times higher than traditional concretes, it can resist bending and can withstand major transformations (such as pressure or dilation) without breaking.

resistant to external aggressions such as abrasion, pollution, weathering and scratching. Its longevity is 2 to 3 times longer than that of conventional concrete.

Ductal[®],



High Strength - Low Shrinkage concrete

Surface Performance for slabs requiring high levels of durability against wear resistance and impact with no surface hardener required.

Rapid Access permitting early loading of the floor, helping to shorten the time to market for new or refurbished buildings.

Early Drying permitting the application of resin or tile toppings earlier, enabling the slab to be used more rapidly.

Extensia™



Early High Mechanical resistance concrete

Develops extremely high mechanical resistance soon after pouring. Its formwork can be removed 4 hours after its plant manufacturing compared to 12 to 20 hours for traditional concrete.

Consequently, the number of daily cycles of form setting and stripping can be doubled, resulting in considerable time savings and productivity gains on the worksite, while offering the same flexibility of use as a conventional ready-mix concrete!

Chronolia®

Micro-reinforced ultra-high-performance

In addition to high compressive strength, durability and abrasion resistance of UHPC, micro-reinforced UHPC is characterized by extreme ductility, energy absorption and resistance to chemicals, water and temperature.

The continuous, multi-layered, three dimensional micro-steel mesh exceeds UHPC in durability, ductility and strength.

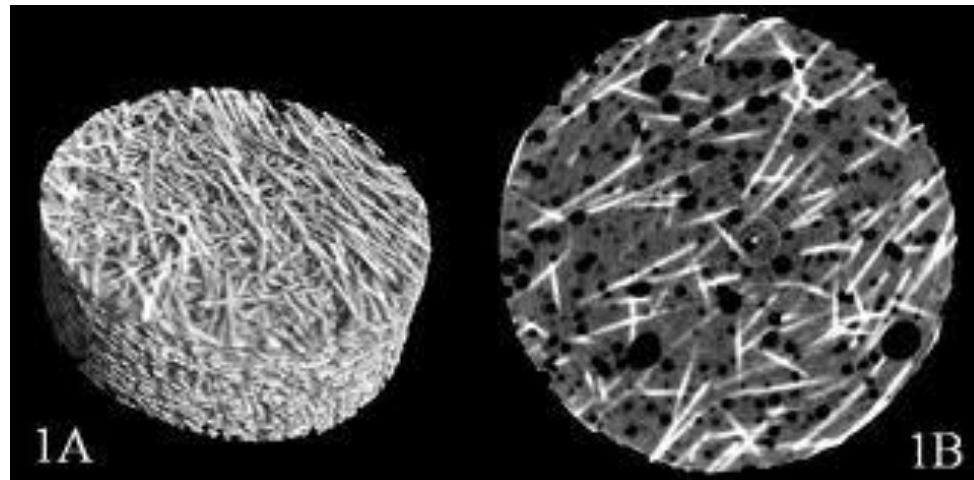
The performance of the discontinuous and scattered fibres in UHPC is relatively unpredictable.

Micro-reinforced UHPC is used in blast, ballistic and earthquake resistant construction, structural and architectural overlays, and complex facades.



Steel and synthetic fibres in Concrete

- Reactive powder concrete is extremely workable, durable and yields ultra-high strengths without using coarse aggregates. Reaching high compressive strengths, this new-age concrete also has tensile strength with the inclusion of steel and synthetic fibres.



Fly ash based geo-polymer concrete

Lots of research being undertaken.
Can be used for road construction.



Self Levelling Concrete

Highly fluid

Concrete flows and spreads effortlessly. It can be poured quickly and provides an exceptional, highly aesthetic finish.

Considerably improves conditions on building sites: Fluidity, it eliminates the tedious chore of vibration.

This improves on-site conditions for workers, as well as worksite quality.

Reduces worksite noise, a source of irritation both for workers and for nearby residents.



Self Compacting Concrete (SCC)



Self Compacting Concrete (SCC) eliminates the need for mechanical consolidation and yields a smooth surface finish without mix segregation. Lafarge's Agilia[®] Screed is a ready-mix, pump-applied, free-flowing, self-consolidating synthetic floor topping.

Acid and chemical resistant cement concrete

Acid and chemical resistant cement concrete technology forms a dense matrix comprised of interlocking crystals and a discontinuous pore structure.

These properties restrict access to ingress and transport of corrosive liquids through the concrete and reduces the potential of reinforcing steel corrosion.

KemROK is a fly ash based, **green cement** that produces superior strength acid and chemical resistant concrete that does not require protective epoxy.



CeraTech's KemROK™



P.O.S.T. (Pre-stressed Open Space Truss) Concrete

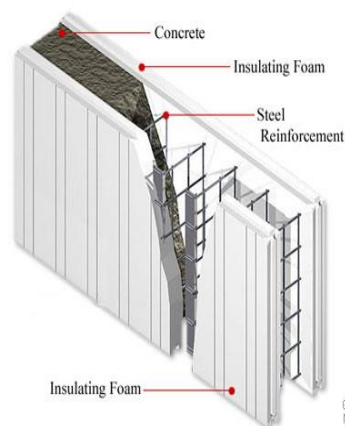
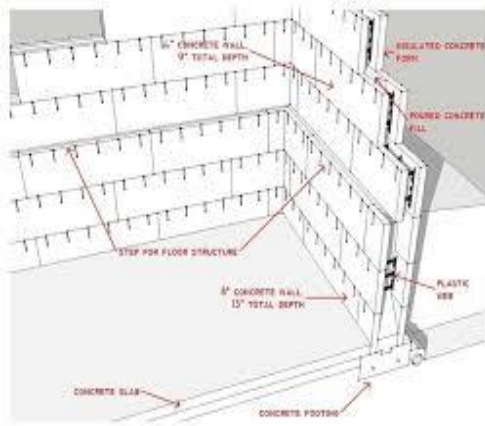
The new P.O.S.T. (Pre-stressed Open Space Truss) provides a solution for long-spans, while maintaining the shallow floor depth of a flat plate system. This system works well for hotel and apartments applications, especially with covered parking spaces in the lower levels.



(Source Americas Cement Manufacturers)

Insulated Concrete Form (ICF)

Insulated Concrete Form (ICF) walls are gaining popularity in the residential and commercial markets. In addition to rapid construction, energy savings and increased durability, owners also gain a healthier and quieter environment. Most recently, blast-test experiments showed exceptional results for resistance to catastrophic loadings, including fire, wind, and earthquakes.



Hybrid construction in Concrete

Hybrid construction marries the benefits of pre cast and cast in-situ concrete for a desired result, such as seismic performance, cost savings, or schedule implications.



(Source Americas Cement Manufacturers)

Other cutting edge advances in Concrete

Vacuum concrete

Shotcrete

Limecrete

Cellular concrete

Cork-cement composites

Roller-compacted concrete

Glass concrete

Asphalt concrete

Rapid strength concrete

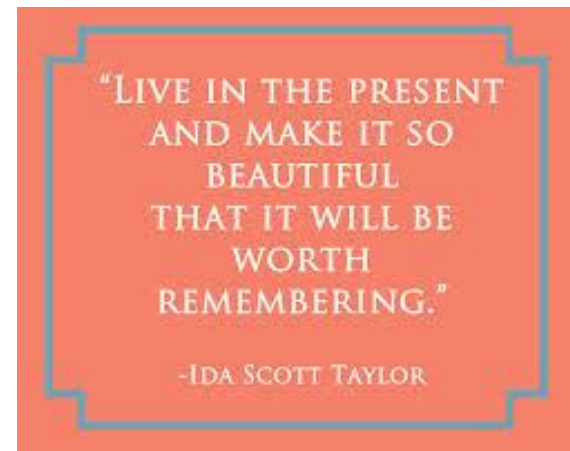
Rubberized concrete

Polymer concrete

Gypsum concrete



Aim for the future BUT
Focus on the Present.



Examples of Products







Copyright © Agrément South Africa, November 2011

The master copy of this document appears on the website:
<http://www.agrement.co.za>

Validity

Users of any Agrément certificate should check its status: all currently valid certificates are listed on the website. In addition, check whether the certificate is **Active** or **Inactive**.

The certificate holder is in possession of a confirmation certificate attesting to his/her status.

SANS 10400: The application of the National Building Regulations

Quick guide

Contents	page 2
Preamble	page 3
Conditions of certification	page 4
Assessment	page 6
Compliance with the National Building Regulations	page 7
Technical description	page 9

P O Box 395 Pretoria 0001
 Telephone 012 841 3708
 Fax 012 841 2539
 e-mail agrement@csir.co.za
<http://www.agrement.co.za/>

Agrément Certificate 2011/399: Sheerflex Coat

Pelican Park

Joe Slove Phase 1 and 2

The Fountains



Fibre Cement Window

- The FibreCrete Windows comprise a combination of fibre cement frames (mullions and transoms), aluminium sashes with monolithic or laminated glazing and ancillary components, viz, lugs, bolts, nuts and screws.



Fibre Cement Windows & Door frames

- Fibre cement frames aluminium sashes with monolithic or laminated glazing and ancillary components, viz, lugs, bolts, nuts and screws.



Infra-Flash Self Adhesive Sealing

- Infra-Flash Self Adhesive Sealant comprises of creped, laminated aluminium foil achieving up to 60% stretchability, one side coated with butyl adhesive and protective release foil. Infra-Flash is available in widths of 200, 250, 300, 450, and 600 mm and 5.0 m long roll.
- Available in anthracite, terracotta and brown.





Spunsulation roofing undertile membrane

- Manufactured from pigmented ultraviolet light-resistant.
- non-toxic flame retarded.
- non-woven.
- polypropylene membrane.
- laminated by means of homogenous polyolefin based film web to both sides of a layer of aluminium foil.

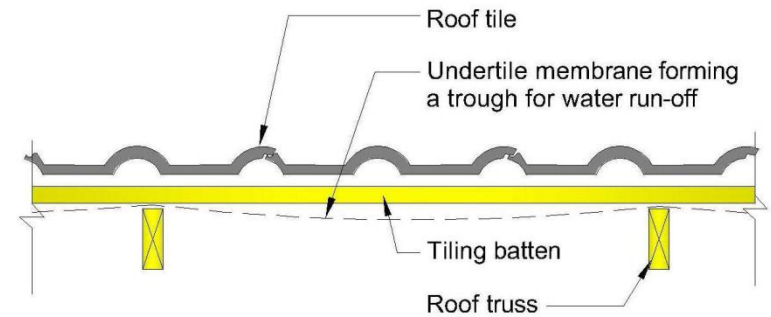


Figure 1: Typical cross-section of roof showing position of undertile membrane

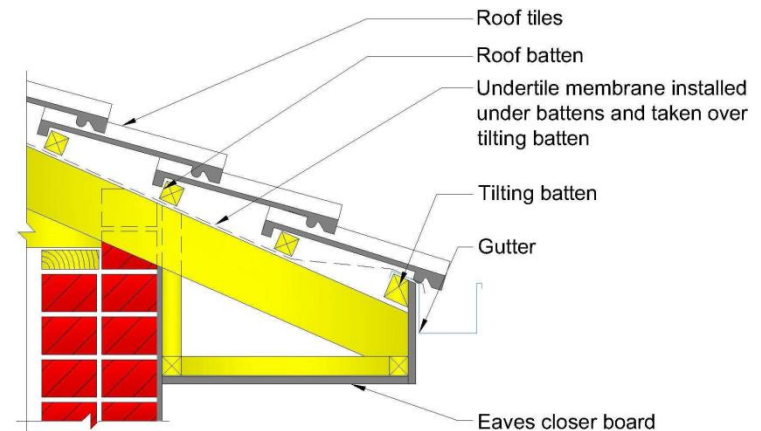


Figure 2a: Closed eaves detail

