World Record Breaking Concrete Solutions
Admixtures for high rise construction
Master Builders Solutions from BASF

Introduction
Admixtures for high rise construction

As towers continue to get higher, concrete plays an ever more vital role in their complex structural design. Building at height presents unique challenges both in terms of design and construction. The economic benefits of using high-performance, high-strength concrete for the structures of high-rise buildings are based on the straightforward premise of ‘more for less’.

Using high-strength concrete means that the column size is reduced and therefore, the amount of concrete, reinforcement and formwork required is consequently reduced. The use of high-strength concrete provides one of the most economical ways to carry vertical loads to a building’s foundation. It also provides performance benefits of early high-strength, volume stability and extended life cycle.

BASF’s range of Admixtures enables concrete to be pumped non-stop to a height of over several hundred meters in the construction of high-rise buildings and skyscrapers. They also stop the various components of the concrete mix from segregating due to the high pumping pressures involved, ensuring a faster construction process and longer building life expectancy.

Setting new records with BASF Admixtures
Jeddah Tower

During the 1990s, concrete pumping soared to new heights – high strength concrete containing BASF admixtures in was pumped to a height of 450 metres in the construction of the Petronas Towers in Kuala Lumpur. Since then, concrete has been pumped ever higher. In 2011 a new world record was achieved when concrete, again containing BASF admixtures, was pumped to a height of 602 metres during the construction of the Burj Khalifa tower in Dubai, which at 830 metres makes it the world’s tallest building.

This record is about to be beaten again with the construction of the new 1,000-metre-tall Jeddah Tower in Saudi Arabia. Unlike the Burj Khalifa, which was constructed using concrete to a height of 602 metres with a further 226 metres of steel, the Jeddah Tower will mainly be a solid concrete building. Although the final height has yet to be revealed the Jeddah Tower will be over 1 kilometer which will require concrete, containing BASF admixtures, to be pumped vertically over 1,000 metres.
432 Park Avenue
New York, United States of America

BASF’s high range water reducing admixtures were used in the construction of 432 Park Avenue. As expected, the construction of a super-tower in midtown Manhattan was an incredible feat for the entire construction team. Standing at 426 metres tall, with only a 28.5 metre square footprint, the structure of the tower is composed of a 30 ft² square reinforced concrete core with 30 inch thick walls.

432 Park Avenue is the tallest residential building in the Western Hemisphere. A luxury condominium tower designed by famed architect Rafael Vinoly, 432 Park Avenue showcases cutting edge design through its square geometric footprint, white facade, and repetitive checkerboard-style window pattern.

- At 426 metres high, 432 Park Avenue is the 3rd tallest building in The United States of America.
- The concrete, which included BASF’s MasterGlenium admixtures, was pumped vertically over 400 metres.
- The rapid construction schedule was a challenge, with a goal of one floor per week for a total of 90 floors.
- BASF’s Green Sense Concrete service also helped reduce CO₂ emissions via a sustainable concrete mix containing 70% cement replacement, contributing to achieving the building’s LEED status.
- The combination of the white exterior colour, the aggressive timeline, and the general requirements of building a superstructure made this one of the most challenging concrete projects that has ever been executed.
- 432 Park Avenue is 426 metres tall with only a small (28.5m²) footprint.
Burj Khalifa
Dubai, United Arab Emirates

To reach this world record the structure of the building had to comply with strict design and durability criteria. One unique challenge was ensuring the concrete mix design for the structural core of the tower was capable of being pumped to formidable heights in extreme climatic conditions (temperatures of between 10°C and 50°C). The structural core of the tower required nearly 170,000m³ of concrete designed with a compressive strength of 80N/mm². BASF’s MasterGlenium high range water reducing admixtures were able to meet this challenge making it possible to pump the concrete, without any interruption, to a height of up to 600 meters.

The Burj Khalifa has redefined what is possible in the design and engineering of supertall buildings. By combining cutting-edge technologies and cultural influences, the building serves as a global icon that is a model for future urban centres and the global movement towards compact, liveable urban areas.

- At 828 metres high, the Burj Khalifa is the world’s tallest building
- World record for vertical pumping of concrete to heights of over 600 metres
- BASF admixtures made it possible to complete two stories per week, instead of one story per week, which is standard in Dubai
- The structural core of the tower required nearly 170,000m³ of concrete designed with a compressive strength of 80N/mm²
- The structure also had to meet a 100-year design life requirement
- Construction of the Burj Khalifa is estimated to have taken 22 million man-hours to construct.
- In total over 330,000m³ of concrete and 39,000 tonnes of steel reinforcement was used in the Burj Khalifa’s construction.
International Finance Centre
Guangzhou, China

The International Finance Centre is an efficient, cost-effective composite structure comprising a reinforced concrete core working in conjunction with the perimeter diagrid frame to provide overall stability. BASF admixtures were specified in the construction of the core to enable the concrete to be pumped vertically to a height of over 400 metres.

Following an international design competition, Wilkinson Eyre Architects was selected to design the 440 metre tower in Guangzhou, which is one of China’s tallest buildings. With 103 storeys, the tower has a mixture of uses including office space, a luxury Four Seasons hotel with a top floor high-end restaurant and bar. Guangzhou International Finance Centre won the Royal Institute of British Architects’ (RIBA) 2012 Lubetkin Prize for the best new international building.

• At 438 metres high, The Guangzhou International Finance Centre is the world’s 16th tallest building
• The concrete, which included BASF’s admixtures, was pumped vertically to a height of over 400 metres
• The building was the winner of the RIBA 2012 Lubetkin Prize
• The beauty of the diamond shaped grid is its inherent stiffness, which in turn gives it its strength. Each diamond is 54 metres or twelve storeys high, reducing the amount of steel required for the construction by a remarkable 20%
• The building utilizes the world’s tallest constructed diagrid structure, the diagrid members are formed from concrete filled steel tubes which provide both good stiffness and fire protection to the structure
• The building was designed to be a low carbon and sustainable building. The shape of the building has been designed to reduce the effects of wind, thereby reducing the necessary size and weight of the structure
Odeon Tower
Monaco, France

Soaring to a height of 170 metres in the heart of the Principality of Monaco, the Odeon Tower is the highest building in Monaco. Logistical considerations for the placement of the concrete were a major part of the challenge. Transporting, pumping and placing the concrete were to stringent timelines and workability control was a key issue. BASF provided full support to the customer regarding the concrete laboratory trial mixes and played a major role in the technical communication with the end client at every step of the concrete mix design process. MasterGlenium, in conjunction with MasterPolyheed, provided the optimised admixture solution for this project.

Within the Odeon Tower there are a total of 259 residences, including 73 private luxury residences, 2 Sky Duplex apartments of 1,200m² each and 1 Sky Penthouse of 3,300m² over 5 floors. Amenities include; retail shops, wellness centre including spa, a fitness centre and a swimming pool, offices and business centres. Additionally there are 10 subterranean levels with 543 parking spaces.

- At 170 metres high, the Odeon Tower is the highest building in Monaco
- 90% of the concrete was pumped – with a vertical pumping distance of 150 metres
- Optimizing the environmental footprint of the high-performance concrete mix design allowed a reduction of approximately 4,000 tons of CO₂ whilst maintaining the required durability criteria
- MasterGlenium, in conjunction with MasterPolyheed, provided the optimised admixture solution
- Over 65,000m³ of concrete was used on the project
- The Odeon Tower is the first high-rise in the city-state to be built since the 1980s
- At a cost of $335 Million, the Penthouse in the Odeon Tower is the world’s most expensive apartment
One World Trade Centre
New York, United States of America

At a height of 542 metres, the One World Trade Centre is the world’s 3rd tallest building. Sustainable design was a central theme of the One World Trade Centre’s development, with the Port Authority of New York/New Jersey imposing a strict requirement for the replacement of Portland cement with recycled materials. In addition, extremely high performance concrete was necessary to meet the compressive strength requirements of the concrete structural columns.

BASF’s Green Sense Concrete program optimizes the concrete formulation to reduce the ecological footprint, conserve resources whilst increasing the structural strength. The concrete mix design with 71% cementitious replacement. The mix replaced Portland cement with the recycled materials, non-cementitious fillers with specialized admixtures to exceed all performance targets specified by the One World Trade Centre project stakeholders. The One World Trade Centre has been awarded LEED Gold certification by the U.S. Green Building Council (USGBC). The 104-story tower now holds the title of the tallest LEED-certified building in the western hemisphere.

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The use of BASF’s Green Sense Concrete technology on the One World Trade Centre saved:
- 590,000 litres of water
- 1,835,494 gallons of petrol
- 25,402,200 kilowatt hours of energy
- 15,000,000 kilograms of CO2
- 504,000 kilograms of fossil fuel equal to 29,872 barrels of oil
Petronas Towers
Kuala Lumpur, Malaysia

The 452 metre, 88-storey twin structure is Kuala Lumpur’s crown jewel. The structure includes a 170 metre high sky bridge between the two towers and is the world’s highest two storey bridge. The buildings are perhaps most noteworthy for their skybridge, which connects them on the 41st and 42nd floors. Although there is no structural benefit to the connection, it offers more than just an architectural flourish, linking the two buildings together, the facilities of each tower around that level can be shared.

Challenges during construction included the need to pump concrete vertically to the full height of 452 metres. This was successfully achieved using new concrete admixture technology developed for such demanding projects by BASF’s state of the art Research and Development facilities. The buildings are also built on the world’s deepest foundations, 104 concrete piles, ranging from 60 to 114 metres deep, were bored into the ground. The foundations, comprising of 13,200m³ of concrete, was poured continuously over a period of 54 hours for each tower.

- At 452m high, the Petronas Towers are the world’s 9th tallest buildings
- BASF admixtures were used in the concrete, which was pumped vertically 452 metres
- The Petronas Towers were the tallest buildings in the world when originally built in 1998, but still remain the tallest twin towers in the world
- The 88-floor towers are constructed largely of reinforced concrete, with a steel and glass facade designed to resemble motifs found in Islamic art
- Each tower used over 80,000m³ of high-strength concrete
- The Petronas Towers were the tallest buildings in the world for a period of six years
Shanghai Tower
Shanghai, China

At 632 metres high, the Shanghai Tower is the world’s 2nd tallest building. BASF’s admixtures were selected to control the workability of the self-consolidating concrete and to ensure that the concrete quality was maintained during the single, uninterrupted pour, whilst meeting a tight schedule. The successful continuous pour of 61,000m³ was placed into the raft foundation over a period of 60 hours, a new world record as the largest volume, continuous concrete pour of civil infrastructure.

Innovative concrete admixture technology also featured in the construction of Shanghai Tower to meet the topping-out schedule, concrete containing BASF admixtures was pumped vertically to a height of over 560 meters at temperatures of up to 40°C.

- At 632 metres high, the Shanghai Tower is the world’s 2nd tallest building
- BASF assisted in the global concrete placement record for construction of the Shanghai Tower’s foundation
- Building raft foundation required a total of 61,000m³ of concrete in one continuous pour
- Concrete with BASF admixtures pumped vertically to a height of over 560 metres at temperatures of up to 40°C
- The 125-storey Shanghai Tower is the tallest building in China
- The Shanghai Tower was designed to achieve both LEED Gold certification & China Green Building Three Star rating
- World’s fastest elevator at 20.5 m/s (73.8 km/h)
The Shard
London, United Kingdom

The Shard is a 95-storey skyscraper in London, that forms part of the London Bridge Quarter development. Standing 310 metres high, the Shard is the tallest building in the United Kingdom and the European Union. Delivering Europe’s tallest tower in record time drove structural engineers to rethink the basic principles of construction and use new techniques in order to go higher and faster than had previously been achieved in the UK.

A massive continuous concrete pour was planned as part of the construction of the three-floor basement box, which had a depth of 13.3 metres and required 15,000m³ of concrete. A total of 16,000 litres of BASF admixtures were used in the record-breaking concrete pour. This pour is the largest UK continuous concrete pour to date, lasting 35 hours and beating the schedule on both time and volume. The structure’s core was slip-formed in reinforced concrete and progressed at an impressive rate of three metres per day, whilst the basement levels were built top down simultaneously.

- At 310 metres high, the Shard is the tallest building in United Kingdom
- The concrete which included BASF’s MasterGlenium was pumped 250 meters high during construction of the central core
- A record-breaking concrete pour for the basement’s construction, the largest UK continuous concrete pour to date
- The actual placement time for 5480m³ was 35 hours, beating the schedule both on time and volume
- 95% of the materials used to construct the building are recycled.
- The Shard delivered a number of firsts: the first core to be built by top-down construction, the UK’s largest concrete pour, and the first crane to be supported on a slipform
Trump International Hotel & Tower
Chicago, Illinois

The Trump International Hotel and Tower is a skyscraper condo-hotel in downtown Chicago. The building, named after businessman and current President of the United States, Donald Trump. Amenities include the 339-room Trump International Hotel, 486 luxury condominium units, 9,300 square meters of riverfront retail space, 960 parking spaces, restaurant, banquet space, health club, spa, lounges and a ground floor beautified by a landscaped riverfront public plaza and a riverfront promenade.

The foundation for the Trump International Hotel and Tower in Chicago measured 60 meters in length, 18 meters in width and 3 metres in depth, requiring approximately 3,500m$^3$ of concrete. The designers opted to use self-consolidating concrete following the successful use of this technology during construction of the Burj Khalifa building in Dubai. Over 30 ready ready-mixed concrete trucks were utilised making 600 trips to the site with the pour lasting 23 hours.

- At 423 metres high, the Trump International Hotel and Tower is the world’s 16th tallest building and the 4th in the United States of America
- Over 30 ready ready-mixed concrete trucks were used making 600 trips to the site. Placement lasted 23 hours and used 3,580m$^3$ of concrete.
- Overall, 137,620m$^3$ of concrete containing BASF admixtures was used during construction.
- The concrete temperature was limited to a maximum of 27°C at the time of placement and 77°C in-place.
- A 56-day compressive strength of 10,000 psi (69 MPa) was specified for the SCC.
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Reduce your footprint and boost your bottom line

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We have portrayed some of our most eco-efficient product solutions for concrete and precast production, construction, civil engineering, and flooring. Find out how you can save money, time and energy.

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