Quadshore™: The world-leading lightweight heavy duty propping solution for temporary construction works

Coates

Equipped for anything

MONASH University

Australia's construction and infrastructure industries rely on temporary works systems such as propping solutions to perform essential work. However, conventional propping systems are often costly and inefficient due to their low capacity-to-weight ratio and bolted module-to-module connections.

Structural props are commonly used to provide temporary support.

This white paper discusses the development of the world-leading lightweight heavy duty structural propping system – the result of a collaboration between Coates and Monash University – in response to a direct industry need. It outlines the industry challenges that prompted the research and development of this temporary works solution, and the benefits that this technology will transfer to end users in the form of safety, sustainability and savings.

Overview

Temporary structures are vital to the construction, repair and maintenance of permanent infrastructure. These temporary structures enable necessary access to assets and provide them with critical support. For example, structural props are commonly used to provide temporary support to resist gravity loads from structures during construction. With Australia in the midst of a major infrastructure boom, and the construction industry forecast to grow 10.6% in 2022 alone, demand for temporary works is similarly set to rise[1,2]. Significantly, most of the infrastructure pipeline is planned for Melbourne, Sydney, Brisbane and Perth, the most densely populated and fastest-growing cities in Australia[3]. Additionally, due to population growth, ageing infrastructure in these urban areas require substantial upgrades [4].

Contents

Challenges with temporary works structures

A key challenge faced by those undertaking temporary works is that traditional propping systems are heavy and cumbersome to transport, assemble and disassemble, particularly in limited spaces, such as those typical to metropolitan sites. This is because the mild or low-grade steel commonly used to make these props results in a low capacity-to-weight ratio.

Due to their heaviness, these conventional propping structures take a lot of time and energy to install and dissemble, requiring bolted connections and specialised machinery to manoeuvre on site. This influences project costs and completion times and can have significant social implications if the infrastructure is out of service for an extended period.

Moreover, conventional propping systems pose challenges around safety due to the need for manual handling and the operation of heavy machinery or lifting equipment. This is particularly important, considering the construction industry has the third-highest incidence of serious injury claims per industry in Australia (13%)[5].

Likewise, historic failures of temporary work structures have resulted in injuries, deaths and significant fines. Research indicates that 38% of infrastructure incidents are related to the construction phase where temporary works are utilised[6].

Researching a solution to an industry need

With the above issues in mind, researchers from the Department of Civil Engineering at Monash University began examining the utilisation of high-grade steel for temporary works structures over a decade ago. As Head of Structural Engineering, Associate Professor Amin Heidarpour is actively involved in the teaching and research of structural engineering. He also supervises the PhD students enlisted in this field of study.

"Working on high-grade steel has a long history within our department. When I started in 2011, we began to focus our research on using this in construction to address the design and engineering challenges around temporary structures," he explains. "Temporary structures are used throughout the lifecycle of a permanent structure – spanning the construction, service and decommissioning phase – and so their design is critical to performance."

Additionally, a core focus of Amin's research is on developing structures and assemblies that use more sustainable materials. In particular, he and his students have been assessing how to better utilise steel.

Steel is cited as among the third biggest producers of carbon emissions, with every tonne produced equating to 1.85 tonnes of carbon dioxide – or 8% of global CO2 emissions[7]. Similarly, the construction industry accounts for 38% of carbon emissions globally[8].

> "Developing a successful system – for applications in the real world – requires more than academic research alone. It requires a partnership between academia and industry."

"We know that steel manufacturing is one of the biggest producers of carbon emissions, so reducing the amount of steel used in these temporary works assemblies can reduce this carbon footprint," says Amin. "Importantly, reducing the carbon footprint is not just about using less material, but involves all the energy required for the transport as well as the assembly and disassembly of these temporary structures on site."

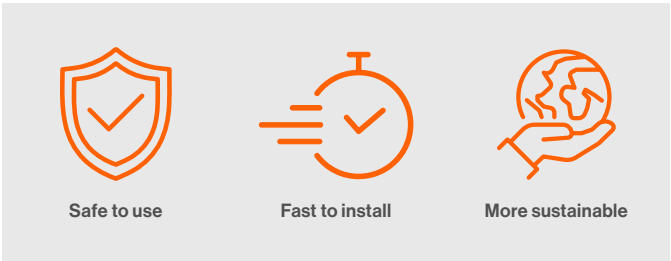
According to Amin, the problems associated with conventional propping systems can be attributed to their use of low-grade or mild steel. This prompted his department to research an alternative.

"Conventional propping systems are associated with increased energy use, increased construction duration and costs and decreased safety on site. This indicates the industry need for a propping system that is both lightweight and high-strength, and therefore more sustainable," he elaborates. "But developing a successful system – for applications in the real world – requires more than academic research alone. It requires a partnership between academia and industry."

Constructive collaboration: Making research a reality

Australia's largest equipment and solutions provider, Coates, recognised the need for an improved temporary works propping system several years ago, as part of their vision to be the market leader in safe, smart and sustainable equipment solutions.

"Through listening to our customers, we were very familiar with the challenges they face in terms of weight, safety, manual handling, lost time injuries (LTI) and the carbon emissions and environmental impacts of using these temporary structures," explains Rafi Tchopourian, General Manager of Coates Engineering Solutions. "We decided to pursue through university faculties a way of designing a new product that would suit the market and tick a number of those boxes. We wanted to create a product that was not only stronger, but lighter, and would be safe to use, faster to install and ultimately more sustainable from an environmental standpoint."



When Amin contacted the Coates Engineering Solutions team in early 2018 about his research into high strength steel for temporary propping applications, the response was swift. By October 2018, Coates and Monash University had formalised a Research Services Agreement that eventuated in the Quadshore 150 propping system – the world leading lightweight and heavy duty propping system – coming to market.

The Quadshore 150 propping system uses lightweight, high-strength steel elements and twistlock boltless module-to-module connections that negate the need for consumables. The working load limit to weight ratio of a 3 metre Quadshore 150 assembly is at least 1.7 times higher than conventional propping systems.

“It’s not superfluous to say that this product is revolutionary – it will absolutely set a new industry benchmark.”

The collaboration was mutually advantageous. For the PhD students working under Amin’s supervision, it meant they had the opportunity to work on a very important and challenging problem and transfer the outcomes of their fundamental research to the real world. For Coates, it meant bringing a more optimal propping solution to their customers – one that will lower costs for temporary works in the construction sector and increase operational efficiency.

Coates Engineering Product Manager, Sudhir Raina, worked directly with the Monash team to develop the Quadshore 150 propping system, providing the invaluable industry insights needed to get the solution market ready.

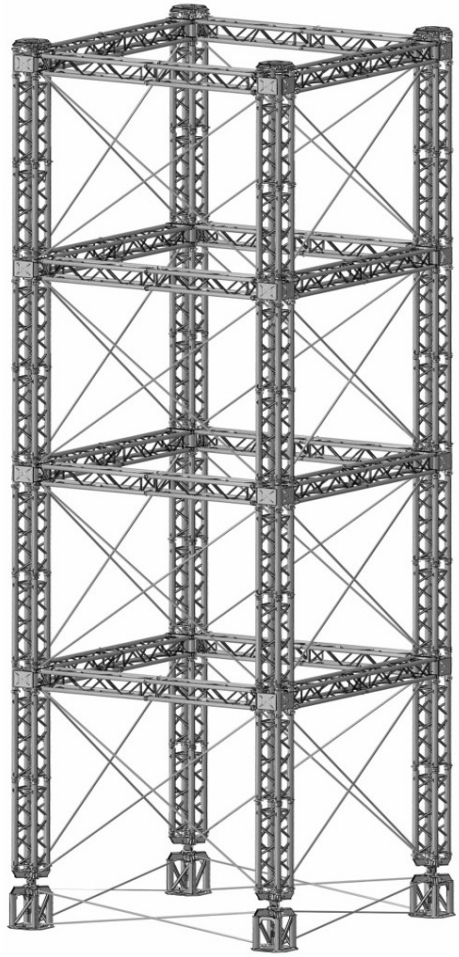
“From a project management perspective, I was essentially in the role of a customer,” Sudhir says. “This meant bringing in the knowledge and experience of the market and supervising the students to ensure their work was in line with the outcomes we were looking to achieve for the end users of this product.”

Quadshore 150 is considered a disruptive innovation in terms of how its design will impact the applications where it will be used and the construction industry at large. Features such as its lightweight but high-strength structural elements as well as boltless module-to-module connections – which exclude the need for consumables – will combine to create significant benefits. Among those are reduced labour, manual handling, storage, installation and de-installation costs as well as decreased transportation and a lower carbon footprint.

“It’s not superfluous to say that this product is revolutionary – it will absolutely set a new industry benchmark,” says Sudhir.

Importantly, the patented Quadshore 150 has been tested and certified to relevant Australian standards.

"The assembly and disassembly time of Quadshore 150 is 60% quicker than conventional systems with the same capacity."

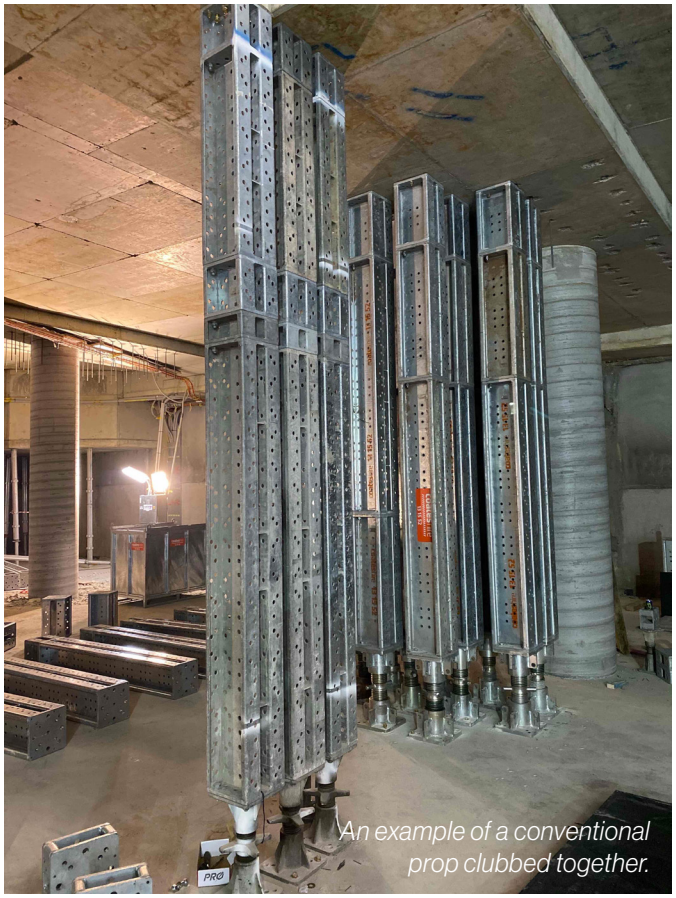


Four-legged Quadshore tower.

Features of Quadshore 150

- Quadshore 150 was developed to create temporary structural solutions consisting simple propping, raking struts and high-rise tower systems. The single and four-legged propping system can carry exceptional loads of up to 170 tonnes.
- The robust finite element model developed for the Quadshore 150 design has been verified by conducting real-scale destructive and non-destructive experimental tests on various lengths ranging from 1.25m to 12m. All experimental tests and validation have been done in accordance with the Australian Standards.
- Quadshore 150 is a modular system. The length of each module varies between 250mm and 2m. A 2m module of Quadshore 150 weighs only 60kg.
- Owing to the patented boltless twistlock connection, the assembly and disassembly time of Quadshore 150 is 60% quicker than conventional systems with the same capacity.
- The working load limit (WLL) to weight ratios of a 3m Quadshore 150 assembly is at least 1.7 times higher than conventional propping systems.
- The working load limits (WLL) of a 3m and a 12m Quadshore 150 assembly is 170 tonnes and 33 tonnes, respectively.
- Quadshore 150 includes a screw thread for fine adjustment to the height. It also includes a mini-stool where a hydraulic jack can be used to safely and simply unload the assembly at removal.
- Quadshore 150 contains a range of end sections (including flat head, cross-head, transfer fixing plate, multi-angle bracket, and needle beam fixing clamp) to facilitate the connection of the interface to the propped and supporting structures.
- The universal joint allows for making four-legged towers that can consist of Quadshore 150 and existing props.

The above data is based on Coates Quadshore 150 technical data sheets that have been certified in accordance with relevant Australian Standards.



An example of a conventional prop clubbed together.

Addressing the pain points

As Quadshore 150 addresses the pain points identified by removing or reducing time and labour costs, manual handling, energy use and consumables, end users stand to benefit in terms of safety, savings and sustainability.

As National Projects Engineer for Coates, Joseph Hovanjec's role revolves around problem-solving and understanding what a customer's objectives are on site. He says the benefits of the Quadshore 150 solution can be considered through a checklist of questions, each delivering to a key performance indicator (KPI).

Basic Propping KPI Checklist Questions	
1 Is it going to reduce the number of props I have on site?	✓
2 Is it quicker to install and deinstall?	✓
3 Is it safer to use?	✓
4 Will it reduce the transport required?	✓
5 Will it reduce labour costs?	✓

Cost savings and efficiency gains

Compared with a conventional propping system, Coates estimates that Quadshore 150 will reduce transport costs by 150-200% due to its lighter weight and higher capacity, which means less equipment, machinery and labour are required on site.

"What's particularly compelling through the customer lens is the reduced transport and speed of installation," says Sudhir. "Quadshore 150 is easily handled and placed into position on site which drives efficiency as it reduces the requirements for heavy operating machinery."

The boltless twistlock connection means assembly and disassembly time is at least 60% quicker than conventional systems with the same capacity.

Quadshore 150's boltless design will also result in significant cost savings on consumables.

"Quadshore 150 doesn't require any nuts and bolts for module-to-module connections, or the corresponding tooling and time that goes into tightening up those connections, so you can install it quicker and with fewer dollars spent," says Sudhir.

Furthermore, the system's high capacity-to-weight ratio eliminates the need for multiple props on a site.

"This is a big advantage to medium and large-scale builders where real estate is at a premium," explains Sudhir. "Previously we may have recommended multiple and even different props clubbed together because the load requirements were so large. With Quadshore 150, customers don't have to go with multiple props, they can just use this one unit which reduces the need for storage on site and frees up valuable yard space."

A safer propping system

Due to its lightweight modular system, Quadshore 150 is intrinsically safer than conventional propping systems due to its ease of assembly and disassembly. This is particularly evident on congested city sites where limited crane access makes it difficult to manoeuvre and position the compenentry. The lightweight and more compact assembly reduces the overall footprint required to install it – a common problem with conventional propping systems.

"Where there has been an insufficient area for machinery, the installation of suitable, safe propping arrangements may have been neglected or not even possible," explains Joseph.

Likewise, in limited spaces where machines cannot fit, the manual handling of temporary works props is necessary. **As Quadshore 150 is considerably lighter, and doesn't require bolted connections between modules, Coates expects the number of LTIs reported by customers will be dramatically reduced.**

"The boltless connectivity of Quadshore 150 modules eliminates all the activity synonymous with bolting – the lifting, the repetitive tightening, the awkward positioning of the body to access bolts and any tight alignment tolerances or pinch points," says Joseph. "Also, because this solution has a significantly smaller site footprint it removes a lot of the site clutter that is synonymous with trips and falls."

Moreover, Quadshore 150 has been designed so that it is easier and safer for end users to make adjustments. There is a range of end sections to simplify the interface to the propped structure and the supporting structure. This includes two variants on the base section – one with a screw thread for fine adjustments to height, and the other with the facility for a hydraulic jack and mini-stool to simplify unloading the prop at its removal.

Lightweight

No bolted connections between modules

LTIs expected to dramatically reduce

Small site footprint

The boltless connectivity of Quadshore modules makes it safer and faster to assemble and disassemble.

A more sustainable solution

Quadshore 150 is more environmentally sustainable than conventional propping systems in a number of ways. As it is made with higher-grade steel, there is less material used in its manufacture and less energy is required for its transportation.

"The smaller carbon footprint of Quadshore 150 extends to all the savings on consumed energy, such as the time and effort of transporting to and from site, and of machinery use and fuel," says Sudhir.

Smaller carbon footprint = a greener choice

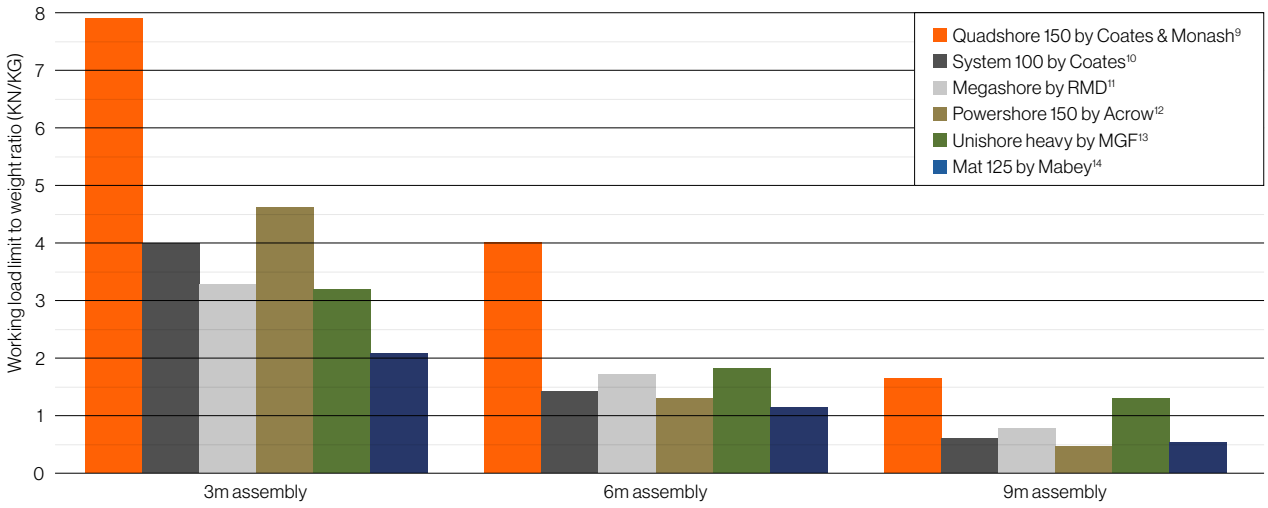
Saves continuously through whole lifecycle of structure

Importantly, these sustainability benefits will be realised throughout the entire lifecycle of a permanent structure, including the negation of consumables. As Quadshore 150 has a boltless connection between its modules that means there will be less waste of any kind of steel componentry. As such, Quadshore 150 also aligns with Coates' commitment to providing customers with more sustainable equipment solutions and their circular economy model of keeping products and materials in use.

"From a sustainability point of view, less steel has gone into the manufacture of the product, but also there are no consumables in its modules at all, so you're not only saving once, you're saving continuously on the lifecycle of the product," stresses Sudhir. "This could be 20 years of not using the nuts and bolts in the modules that you would with a conventional prop."

Quadshore incorporates important elements identified in the United Nations Sustainable Development Goals – namely Goals #4, #9, #11, #13 and #17.

How Quadshore™ 150 compares



***The above graph has been produced using publicly available data.**

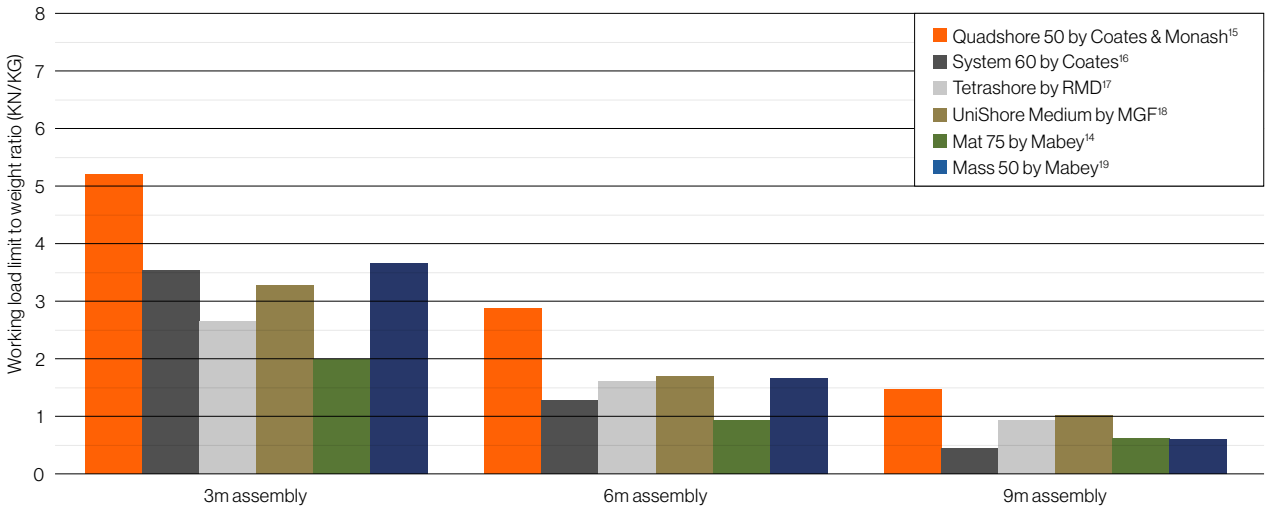
Medium-duty Quadshore™ 50

Coates and Monash have also collaborated together to create the Quadshore 50 solution – a smaller version of the Quadshore 150.

- The working load limits of a 3m and 12m Quadshore 50 propping system are 60 and 22 tonnes respectively
- The working load limit (WLL) to weight ratios of a 3m Quadshore 50 is at least 1.4 times higher than conventional propping systems.
- Quadshore 50 is also a modular system ranging from 250mm to 2m. The 2m module weighs only 35kg.
- Quadshore 50 was tested and compared with System 60 and Trishore and the assembly/disassembly time was found to be 40% quicker than the other propping systems.
- Quadshore 50 was tested and validated to Australian Standards.

***The above data is based on Coates Quadshore 50 technical data sheets that have been certified in accordance with relevant Australian Standards.**

How Quadshore™ 50 compares



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Changing the future of temporary works

According to Coates, the Quadshore propping system will indelibly change the landscape of the temporary works arena because its design facilitates a wide array of applications and benefits. Where conventional props are limited – namely in that they offer either a single leg prop or a tower – Quadshore can manage both of those applications.

"For example, if you have a bridge extension or if a bridge needed to be upgraded, Quadshore 150 is the ideal product to build multiple leg towers with cross bracing to give you that uniform load," explains Rafi. "I call it the big LEGO kit. As a temporary works propping solution there are few limitations as to what it can and can't do."

As Quadshore 150 is extra high – extending up to 12 metres unsupported – this means it can be used in many applications where conventional propping has proven difficult to manage because conventional props need to be laterally supported.

"I envisage Quadshore 150 being used for crane outrigger support, the conventional structural support of buildings, demolition, and in ground support such as loading decks on buildings for material handling," says Rafi.

Ultimately, Coates believes end users in the construction segment will gravitate towards Quadshore 150 because of its strength, capacity and versatility.

"It's a standout product that has no competition in terms of addressing the pain points our customers have expressed to us," he states. "We achieved all the goals we wanted from the outset in terms of safety, sustainability and savings from end-to-end efficiencies."

Quadshore 50 selected components.

"I call it the big LEGO kit. As a temporary works propping solution there are few limitations as to what it can and can't do."

Quadshore 150 selected components.

A continued commitment to R&D

While the Quadshore 150 and Quadshore 50 products have been finalised and are ready for market, the collaboration between Coates and Monash University will be ongoing. In fact, the Quadshore 150 solution is just one of several products in the pipeline. Funding under the Research Services Agreement between Coates and Monash has been directed towards a ground shoring system and lightweight tilt props that are currently in the R&D phase.

Aligned with Coates commitment to better equip customers with safe, smart and sustainable solutions, the objective of their R&D programmes and agreement with Monash is to create superior solutions that address industry pain points.

Ongoing collaboration between Coates and Monash University

Several products in the pipeline

"Coates is committed to R&D in the engineering solutions business because we want to continue to innovate and better equip our customers with lighter, stronger, more sustainable and robust temporary work solutions," says Rafi. "I believe the relationship that Coates has formed with Monash University is one that will continue for many years to come – we see Monash as a strategic R&D partner and look forward to what innovations future research students will bring."

In summary

After identifying the market need for a high-capacity, lightweight structural prop, Coates and Monash University have successfully collaborated to develop the Quadshore temporary works solution. Through the use of high-grade steel, Quadshore will require less labour, handling, storage, transportation, installation and de-installation. This translates to considerable time and cost savings, increased safety and a lower carbon footprint.

LESS:
Labour | Handling | Storage | Transportation
Installation | De-installation | Cost | Carbon footprint

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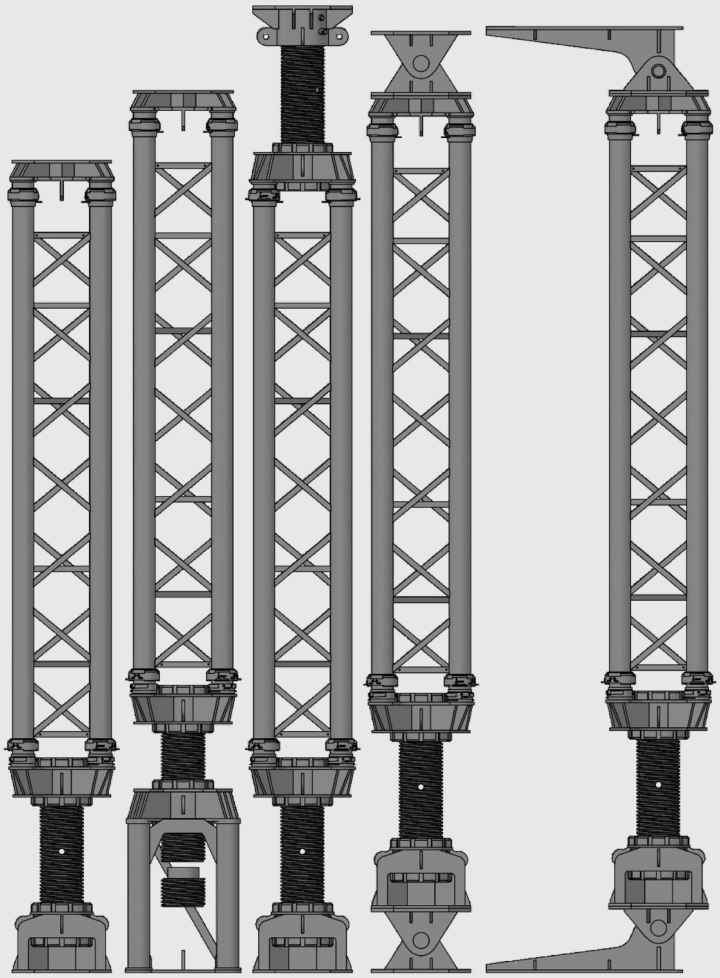

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