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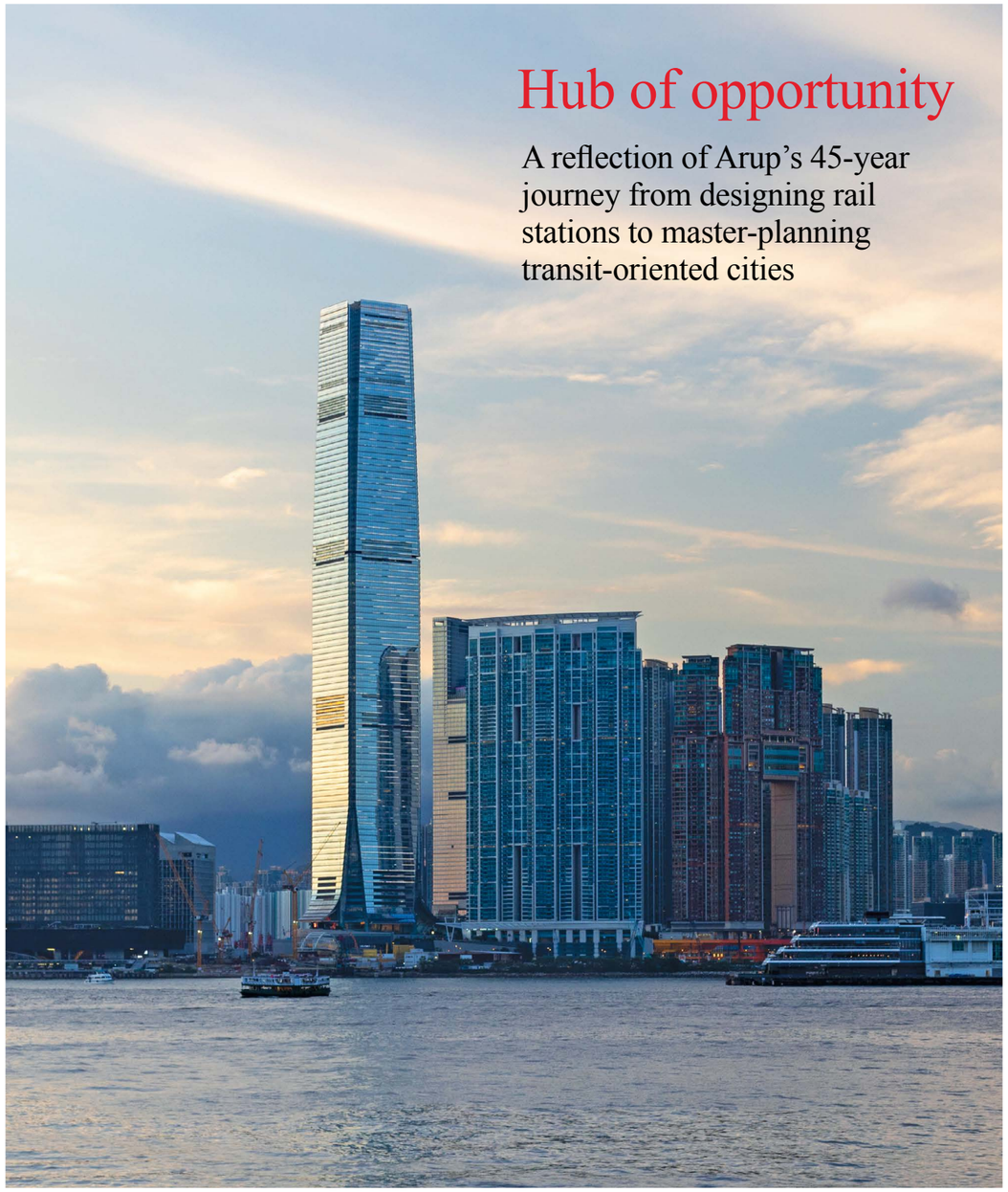

Hub of opportunity

A reflection of Arup's 45-year journey from designing rail stations to master-planning transit-oriented cities

Foreword

Transit-oriented development (TOD) is a master-planned mixed-use development centred around a public transit station, such as a metro station. In East Asia, the concept of TOD was non-existent when cities such as Hong Kong and Singapore began to build their metro systems in the 1970s and 1980s. But now widely recognised as a sustainable planning solution, TOD is playing an essential role in accommodating the region's population, housing and employment growth while promoting efficient transport options needed for a long-term sustainable future.

Looking back on our 45 years of technical excellence, we have formulated innovative structural solutions and advanced construction methods to enable the integration of high-rise residential and commercial developments into compact TODs. Forty-five years on, we take pride in delivering complex TOD projects that make a positive impact on many cities across East Asia and leave a lasting legacy, such as the landmark projects mentioned in the Cover Story as well as the more recent ones featured in more detail in the Technical Solutions section.

Recognising the benefits of TOD, governments in East Asia are actively promoting TODs and increasingly transit-oriented cities. Felix Ma, Director and China Cities and Advisory Group Leader at Arup, shares his views on China's latest urban development strategy with TOD and why taller is no longer better in the Profile section. James Sze, Arup's Leader of Geotechnics, Maritime & Energy Group in Hong Kong, gives an account of how he has overcome difficult ground conditions since joining Arup in 1995 in his profile.

While a well-designed TOD creates a healthy mix of uses that balance living, working, entertaining, and commuting, it requires strategic planning and technical implementation, both of which are essential to maximising the value of an investment in transit infrastructure and positive impact on the community it serves. With a solid track record of planning, designing, and engineering transport infrastructure and TODs, Arup has the experience, capability and resources to effectively deliver your next TOD project.

FIRST is a publication produced by East Asia Arup University (AU) for our clients and partners, exploring design, innovation and technical solutions for the built environment. It takes its name from the unique model of AU: Foresight, Innovation, Research, Sharing, and Training.

If you have any thoughts, questions or comments, we would love to hear back from you at ea.arupuniversity@arup.com.

Contents

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A reflection of Arup's 45-year journey from designing rail stations to master-planning transit-oriented cities

Kowloon West is a world-class example of how a multi-modal transit hub can provide seamless connectivity to international, national and local transport links.

Across East Asia, transit-oriented development (TOD) has become the growth engine of the region's urban and economic development. As planners, designers and engineers, Arup plays a pivotal role to ensure infrastructure keeps up with that growth. Over the past four decades, Arup has worked alongside organisations such as Hong Kong's MTRC to build transit systems that foster urban development and fuel economic growth for the region.

Our journey began as a trusted engineer supporting the development of Hong Kong's metro system in the 1970s, having introduced innovative transfer plate systems to the structural design of depots and stations, therefore allowing high-rise, high-density residential and commercial developments to be built directly above. As mainland China embarked on massive infrastructure development in the 1990s, we have expanded our presence across the mainland and the rest is history.

To date, Arup has become a leading consultant on rail, transportation and TOD projects in East Asia, offering a comprehensive range of services including pre-planning, planning and design, urban design, transportation consulting, operation management and engineering implementation services.

Innovative structural design transforms depots into high-density TODs

MTRC's R+P (rail plus property) model is now a widely cited example of how high-rise residential and commercial developments built directly above a rail station or depot can maximise land value capture (LVC), allowing the transit operator to partially or in Hong Kong's case, fully fund its capital costs. Today, MTRC's approach to TOD is referred to as a role model for city planners and transit operators around the world to reduce long-term public transport subsidies.

Our very first work on Hong Kong's MTR stations at Central (previously known as Chater) and Admiralty was completed in 1980. Afterwards, we obtained several commissions for extensions to Central and Admiralty for the Island Line as well as the deep station at Wan Chai. At that time, it was challenging to build a community above a depot, given the inherent issues around structural integrity, noise and airflow; let alone the sheer volume of transiting passengers. However, we overcame the many technical and site challenges and managed to design transfer plates and depot structures with

The Telford Gardens development above the Kowloon Bay depot

computer analysis to support high-rise blocks of 30 storeys and above.

Our ground-breaking analytical work for the development above Kowloon Bay depot was crucial in economically supporting the Telford Gardens residential development of 41 apartment buildings and a large shopping centre. In this project, we designed an innovative transfer plate system allowing the residential buildings to be supported on the grid of depot columns that had been designed by others. The same development model was adopted by MTRC for the construction of the Tsuen Wan Line depot located beneath the Luk Yeung Sun Chuen development, which includes 17 high-rise residential towers, schools and commercial facilities.

The construction of the Island Line resulted in Chai Wan depot and the even more extensive Heng Fa Chuen residential development. Knowledge gained from the design of Tsuen Wan depot was reapplied to the planning of Chai Wan depot, that time allowing the potential developer more freedom of choice in the form of residential towers above the podium.

As the former Kowloon-Canton Railway Corporation (KCRC), which merged with MTRC

Completed in 1984, Luk Yeung Sun Chuen is built above the Tsuen Wan Line depot and adjoins Tsuen Wan station.

in 2007, entered the property market in the 1980s, we carried out the complete re-planning and the construction of their existing Ho Tung Lau depot to form a large podium structure now supporting the Royal Ascot residential development. In the years that followed, we planned and designed Tai Wai depot, where Arup was engaged as a multidisciplinary consultant, with a podium now supporting very tall residential towers.

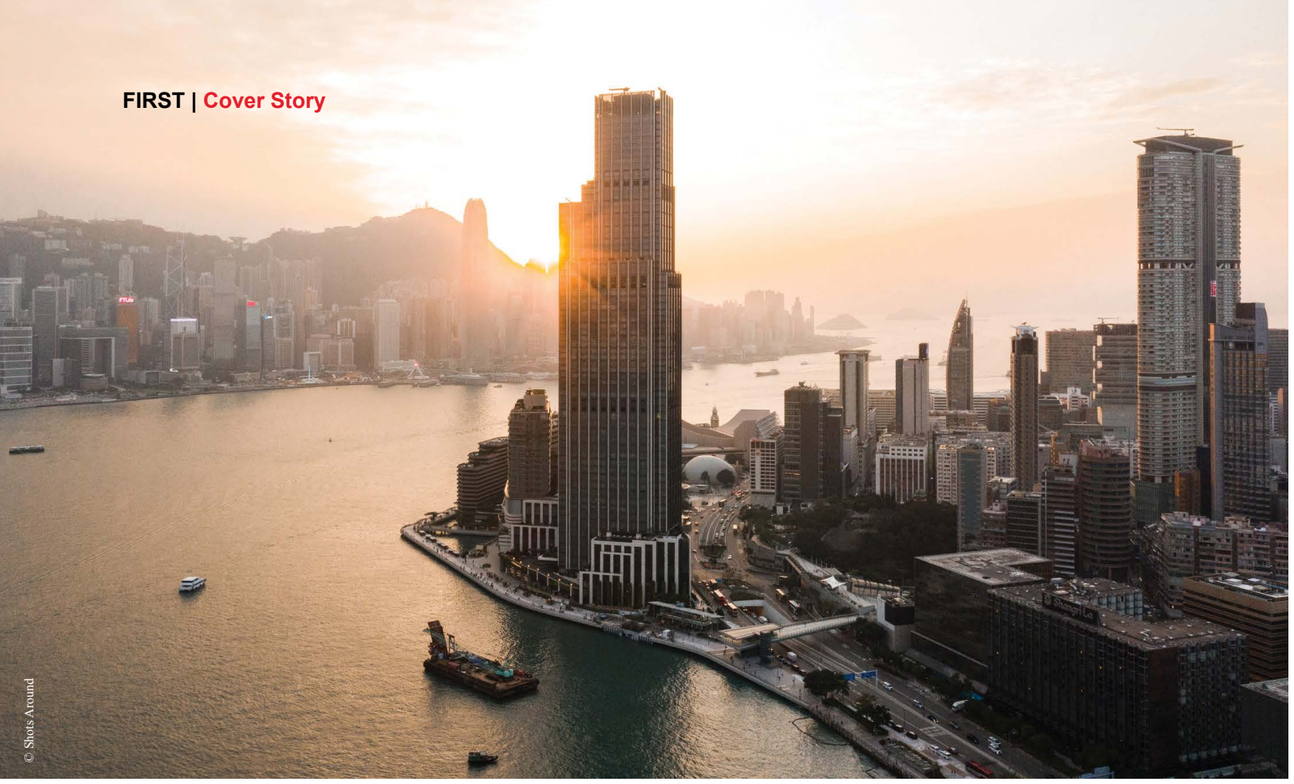
Before the work at Tai Wai, we were also engaged to design the high-rise residential development above the KCRC Tuen Mun LRT depot, having completed the design of the depot itself some years earlier. Our latest MTRC depot work was carried out at Wong Chuk Hang station that serves the South Island Line.

Lantau Airport Railway projects lead Hong Kong into new era

With the construction of the Lantau Airport Railway in the 1990s, which resulted in the development of Tung Chung New Town, we were heavily involved in the engineering design works on the key stations along the Tung Chung/Airport Express Line, including the megastructures supporting Hong Kong, Kowloon and Tsing Yi stations' mixed-use developments, as well as key facilities within the airport area.

It is worth noting that we provided innovative geotechnical and structural engineering and design for the International Commerce Centre (ICC) and the Two International Finance Centre (IFC) towers, located next to the Kowloon and Hong Kong stations, respectively.

Now integrating Kowloon station, Hong Kong West Kowloon station (the high-speed rail to mainland China) and Austin station into one massive TOD, Kowloon West is a world-class example of how a multi-modal transit hub can provide seamless



3D pedestrian simulation methods and analyses were employed to optimise the layout design of Victoria Dockside in Tsim Sha Tsui, Hong Kong.

connectivity to the airport, national high-speed rail network, local metro network and multiple public transport links. The Kowloon West TOD also encompasses hotels, office towers, prime retail, upscale residential developments, as well as the iconic West Kowloon Cultural District.

Arup was responsible for the structural design of six out of the seven development packages above Kowloon station and is now designing the topside development above the high-speed rail station.

Tung Chung New Town development as a whole is another example of a thoughtfully master-planned transit-oriented community, including Tung Chung station that was designed by Arup. The latest Tung Chung New Town Extension project, covering areas on the eastern and western flanks of the existing Tung Chung New Town, is now under construction and is set to achieve the first population intake in 2024.

We were commissioned in 2012 to carry out a planning and engineering study and were later responsible for the engineering infrastructure works on the western flank. In 2020, we were commissioned in a joint venture consultancy to carry out the full architectural and engineering design of a new station in Tung Chung East New Town as well as the MEP work at Tung Chung West station.

TODs grow to become transitoriented communities

In more recent years, Hong Kong's TODs have become bigger and more complex with more interconnected facilities inside. After nearly 20 years of planning and development, the LOHAS Park station development in Tseung Kwan O is taking shape. The project is divided into 13 phases, with the latest phase now being expected to complete beyond 2025.

Over the course of the development of Yuen Long station designed by Arup and the YOHO community, we were engaged by clients from both the private and public sectors to carry out multiple traffic and pedestrian flow studies. Our works resulted in the creation of a community-wide footbridge system connecting several residential developments as well as different shopping arcades to Yuen Long station.

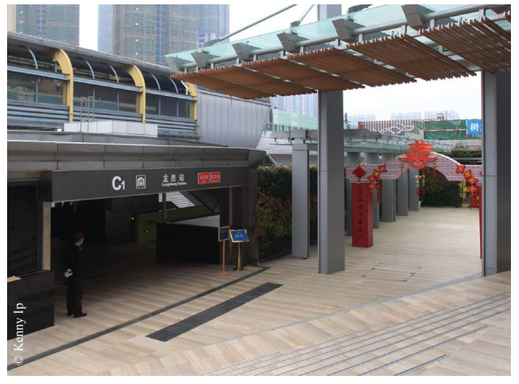
Enhancing walkability and accessibility by streamlining the pedestrian flow and spatial co-ordination has become an important transportation strategy vital to the success of TODs. For Victoria Dockside, a prime shopping and office complex connected to the Arup-designed East Tsim Sha Tsui station, and the redevelopment project at Sai Yee Street and Mongkok East station, we employed 3D pedestrian simulation methods to investigate the pedestrian flow movement and its distribution to optimise layout design, make better use of aboveground and underground spaces, and reduce congestion.

Shenzhen Metro Line 4 marks new milestone for Arup

As well as a portfolio of iconic landmarks we have delivered in Greater China, we have played an important part in the urbanisation of the region's many cities. Including mainland China, Hong Kong, Macau and Taiwan, Arup's TOD portfolio has more than 200 projects so far in the region.

Shenzhen Metro Line 4 is the first metro project we worked on with Hong Kong's MTRC in mainland China. In the early 2000s, to cater for the rapidly growing population of Shenzhen, the city's authorities undertook extensive infrastructure development, including plans for an underground metro system. Arup delivered preliminary through to detail design of the Shenzhen Metro Line 4 Phase 2 which comprises 20.5km double-track urban railway with a total of 15 stations across two phases and a large depot at Longhua and its associated topside development.

In addition to the multidisciplinary services we provided, our traffic consulting team also worked closely with the study team to provide an overall transport strategy, considering such details as walking distance and linkages for pedestrians, vehicular access to the depot podium level, and



Shenzhen Metro Line 4 (Longhua Line)

provision of effective car park arrangement and circulation strategy. Our work included sophisticated traffic queuing modelling analysis to demonstrate that the development would not cause congestion and queuing issues in the future.

As the project required a topside development, it exceeded the limit of China's building code at that time. We overcame this challenge by performing targeted analyses and co-ordination with local seismic experts, resulting in planning approval.

Global leader in TOD design and planning

Drawing on the success of the Shenzhen Metro Line 4 Phase 2 project, we have extended our comprehensive range of rail consultancy and planning services to various transport hubs, rail stations and TODs in Shenzhen, Guangzhou, Shanghai, Hangzhou, Jiaxing, Suzhou, Qingdao, Yantai, Chongqing and Macau in the past 15 years.

In addition to the TOD projects featured in this issue, including Foshan Metro Lines 2 and 3 and the Chongqing Shapingba TOD, we have been engaged in the planning and design works of Guangzhou Metro Line 7 west extension, Shanghai Longyang Road urban hub connectivity, Beijing Metro Lines 3 and 12 Dongba depot, Nanjing Maqun transport hub TOD, Shanghai Xinzhuang station TOD, Macau Reclamation Island E TOD, Shanghai FTZ Lingang New Area spatial planning, Shenzhen Xili Railway Hub, Shenzhen Luohu Buji River urban design, Shenzhen station and Luohu Port urban design – to name a few.

From conceiving the Hong Kong Shenzhen West Corridor to providing infrastructure consulting services for Qianhai, we have embarked on another impactful journey of helping forge closer ties between Shenzhen and Hong Kong and bringing different cities across the Greater Bay Area closer together with TOD.

The role of stations themselves is evolving as they are reimagined as hubs for commerce, recreation and retail. Stations such as Kowloon station in Hong Kong are destinations in themselves, while station developments can be the focal point for local or regional regeneration, as seen with Foshan Metro Lines 2 and 3.

And topside developments are likely to become more common in the fast-growing Southeast Asia region, where continued urbanisation and rising property prices will prompt local authorities, landowners and transit operators to seek to maximise return on their investments and better serve their communities with TODs. Arup is now helping several Southeast Asian countries such as the Philippines, Thailand and Vietnam plan and develop their future multi-modal transport hubs and TODs.

From the Metrolinx Finch West Light Rail Transit project in Toronto and the Washington DC Union Station Concourse Modernisation project we are currently working on, to our work enhancing the Zuid Station, a metro and rail station in Amsterdam, Arup's journey of transforming cities around the world continues as it has for the past 45 years.

A rail for two cities

Bridging the financing gap and maximising the social impact for investment in rail infrastructure

Client:
Land Resource & Urban and Rural Planning Bureau of Foshan City; Foshan Railway Investment Construction Group Co. Ltd.

Arup's scope of service:
Transport strategy, urban planning/ design, railway design advisory

Foshan Metro Lines 2 and 3 are set to open in 2022

Located about 180km away from Hong Kong and 25km away from Guangzhou, Foshan is a prefecture-level city in southern Guangdong and the third-largest city in the Pearl River Delta Economic Zone, now being integrated into the Greater Bay Area (GBA).

Commencing operations in 2021 and 2022, respectively, the Foshan Metro Lines 2 and 3 are two of the most exciting new additions to the GBA's transit system, bringing Guangzhou and Foshan closer together. The completion is expected to expedite the economic development in the GBA.

As early as 2013, Arup was commissioned to act as the lead consultant to manage the planning of Foshan Metro Line 2 (17 stations) and Line 3 (35 stations). Arup's scope of service includes urban planning, site selection, transport strategy advisory, land value optimisation, core station urban design, property market research and financial modelling of infrastructure projects involving land and property.

With a total of 52 stations spreading along Line 2 (Phase 1) and Line 3, not only have these nodes of transport become stopovers for people to commute to work, but each station is designed around a particular model or land use to establish a practical basis for future planning and development.

Key challenges

Since the goal of TOD is to create mixed-use communities within walking distance of transit stations, the problem is that communities are fragmented. In Foshan, there are pockets of agricultural land and there are also historical and cultural heritages that need to be preserved.

During preliminary planning for these two metro lines, Arup's planning team studied these constraints and identified potential sites to establish new compact transit corridors that would link a number of activity centres to turn them into dynamic clusters.

From the economic perspective, the construction, operation and maintenance of railways are costly. To close the financing gap, the client cannot simply rely on public financing or banks. They, therefore, looked for a sustainable financing model that allows for the participation of private investors and developers looking to profit from investing in TOD.

Foshan metro rail network

Moreover, project stakeholders are often not communicating with each other on interface management, not to mention their different interests, values, project orientations or cultures. The client needed an experienced lead consultant to closely engage with multiple stakeholders in the planning phase to resolve potential interface issues.

Arup acts as lead consultant

Arup was the lead consultant for the planning of these two metro lines, not only considering how to bridge the financing gap by consolidating land uses to maximise land value with TOD planning, but also helping maximise the social impact that takes walkability, liveability and sustainability into account. We also advised on policies and regulatory frameworks that would facilitate the planning and implementation of TOD projects in the future.

Achieving optimum land use allocation

Our aim was to develop a TOD model that could achieve an optimum land use allocation to maximise transit ridership and land utilisation.

After studying the land conditions and existing land uses, we created a diversified TOD model that is adaptable to local contexts and highly scalable to cater for a multi-modal hub and real estate

Arup suggested changes to optimise rail alignment and station/ depot locations to maximise the potential for topside property development.

developments. In other words, no matter the station is placed in a town centre, on the outskirts, or in a new suburb area, a model was created for each station that would be fit for purpose.

Besides land use planning surrounding each station, we also reviewed the proposed rail alignment and carried out a feasibility study under the urban planning context. We then suggested changes to optimise rail alignment and station/depot locations to maximise the potential for topside property development.

Arup advised on the design of Linyue West station to maximise developable space and improve the passenger's comfort.

Clustering approach to maximising development value

Unlike nearby Tier-1 cities such as Guangzhou or Shenzhen, Foshan is classified as a Tier-3 city, where the level of urbanisation and concentration of high-value economic activity are lower than other Tier-1 counterparts. To create new value and drive growth, it is important that the sites surrounding different stations be reorganised into various clusters based on their potential for development and social value.

As such, we formulated different masterplans and models to guide future growth and identify resource needs. For example, since Linyue East station is the closest stop to Guangzhou South station, the surrounding land could be zoned to provide commercial space to cater to Guangzhou's spill-over demand for office space.

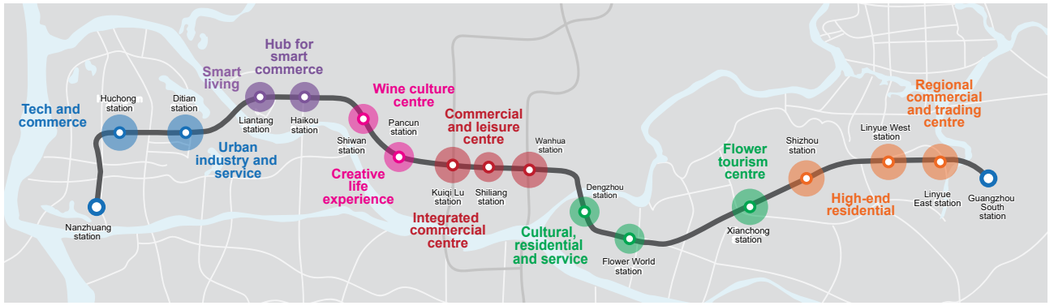
The second, third and fourth stations from Guangzhou, namely Linyue West station, Shizhou station and Xianchong station, respectively, were suggested to be primarily residential zones, or commuter towns, for those preferring to live in a lower-density environment while enjoying connectivity to Guangzhou.

Chencun Flower World, as its name suggests, is a famous flower trading town. Therefore, Chencun Flower World station, as well as its two neighbouring stations, Dengzhou and Wanhua, would be positioned to become a destination of 'flower tourism' mixed with hospitality and retail elements. By the same token, the sites surrounding other stations were master-planned based on their historic fabric and leveraged it to create value.

Dynamics of rail design and community planning

At the station level, Linyue West station, one of the most complex sites, is an example of how we link the dynamics of rail design with urban planning. There are two lines interchanging at the station, along with a depot in the middle of a site, which posed a challenge to our urban design and flow. The station is only two stops away from Guangzhou high-speed rail (HSR) station, which makes the site the natural choice for high-density development. Our goal was to plan a mixed-use scheme of the right scale, at the right density, while providing a strong north-south link through the depot.

The station was initially designed to sit directly beneath Linyue Avenue, which limits the amount of development potential due to a large amount of floorspace required for mechanical operations. To increase developable space and provide a more comfortable environment for pedestrians, we set the depot back by 300m from the main avenue and set aside space for high-value commercial land uses in between. We filled the height gap between the street and the depot with stairs and landscaping to enhance aesthetic effects.



Arup formulated different masterplans and models to guide future growth and identify resource needs by reorganising areas surrounding each station into different clusters.

Mind the financing gap

After optimising land uses surrounding these metro stations, we further estimated the projects' financing gap. Then, we advised on the optimal land use mix and development density and estimated how much land sales revenue the identified land plots could generate based on a study of the land and property market. After we had established the initial assessed value of all the land planned, the transit authority realised that public funds and private investment would be sufficient to cover construction costs.

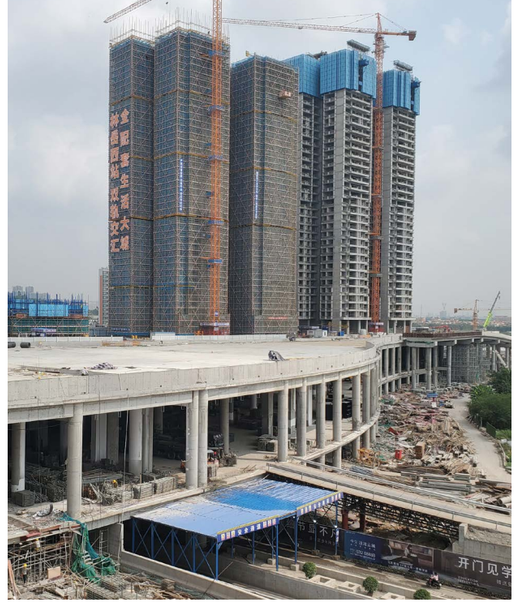
Managing multiple stakeholders

As the lead consultant, we were committed to involving and working co-operatively with all stakeholders. We streamlined the workflow among the planning bureau, metro operator, subdistrict governments and potential investors. Apart from urban planning, we worked closely with different teams of planners, architects, engineers, property consultants and legal consultants to maximise development potential and seek to reduce time and costs. Drawing on our rail engineering expertise, we also advised on station locations and rail transit alignment.

Multidisciplinary leader in TOD planning and design

This TOD study for Foshan assembled an interdisciplinary team from different Arup offices across China, including Shanghai, Shenzhen and Hong Kong. After this study, we have been entrusted with the role of lead consultant for various more landmark TOD planning projects in China, such as the Shanghai Free Trade Zone Lingang New Area, Shenzhen Xili Railway Hub, Shenzhen Luohu Buji River urban design, and Shenzhen Station & Luohu Port urban design.

With a growing TOD planning portfolio in China, Arup is proven adept at identifying the mix and density of TODs and necessary improvements that would both capitalise on transit assets and help to support metro systems through comprehensive analyses of market, socio-economic, neighbourhood and site conditions.

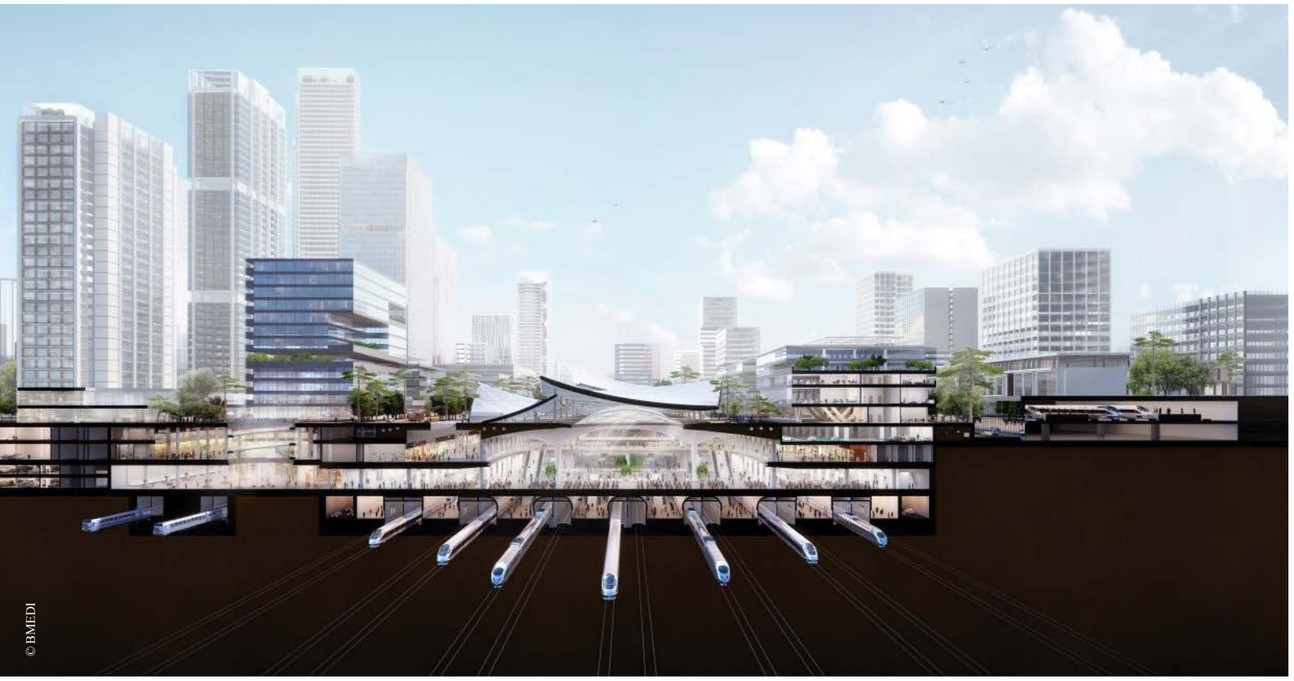


The Linyue West station TOD under construction

Relevant United Nations Sustainable Development Goals (UN SDGs)

Designing fire safe high-speed rail hubs

As exemplified by the Beijing Sub-centre Station project, Arup's global expertise in fire-engineering complex multi-modal transit hubs is valued by railway clients and design institutes in China.



Beijing Sub-centre station is designed to serve six HSR lines, one existing railway, two inter-city railways, one city express line, and three local subway lines.

Client:
Beijing General Municipal Engineering Design & Research Institute Co., Ltd.

Arup's scope of service:
Fire engineering

The rapid expansion of China's high-speed rail (HSR) network is expected to make China an important player in global rail. To support its rapid expansion while maximising land uses on the ground and improving the passenger experience, HSR stations are increasingly built into underground as part of complex multi-modal transit hubs, allowing passengers to effortlessly switch between different transit options, including HSR, metro, intercity coaches, local buses, taxis, and ride-share services. Fire safety is a key concern in the planning and design of underground HSR and transport hubs that integrate multiple transit modes and above-ground developments, such as office and residential towers, all of which collectively form a transit-oriented development (TOD).

About Beijing Sub-centre Station

Located in the sub-administrative area of Tongzhou, Beijing, Beijing Sub-centre railway station occupies a total site area of approx 70ha, with a floor area of approx 1,280,000m^2 underground, plus approx 1,390,000m^2 of mixed-use space overground. The HSR hub is built entirely underground. When it is open in 2024/2025, the HSR hub is set to become the largest underground HSR hub in Asia. The station is designed to serve six HSR lines, one existing railway, two intercity railways, one city express line, and three local subway lines.

Challenges of meeting multiple code requirements

As China's transport hubs grow to include more transit modes, fire engineers are tasked with meeting multiple code requirements, which can be challenging. To secure the authorities' approvals before opening, the design of Beijing Sub-centre HSR station was required to abide by multiple fire safety codes governing commercial, metro and railway stations, covering building structure, passenger evacuation, fire emergency lighting and exit signs, safety management of assembly occupancies, firefighting, emergency evacuation plans for the connected developments, etc.

Our solution has effectively reconciled an open-plan, porous station design in compliance with different fire safety codes. By optimising compartmentation and with the shared use of evacuation routes, our solution allows for seamless open plan designs to not only be fully integrated with the most stringent fire safety regulations but also enhance the passenger's experience while retaining the aesthetics of the architectural design. Fire risks concerning the retail and other commercial facilities located within the complex were also properly mitigated.

Developing a customised fire strategy

With the critical design parameters from the client and local railway design institute, we contributed our experiences with fire safety engineering from Arup's other local and overseas underground rail stations, including Beijing Daxing Airport, Shenzhen Futian and Qianhai stations, provided constructive feedback on the HSR hub design, and discussed the ideas with the team to formulate implementation solutions.

During the strategy development process, we worked closely with the local railway design institute to develop a customised fire strategy, which includes un-compartmented platforms/concourses and interchange spaces that link to commercial and other retail developments. During the pre-design stage, we advised on the design and made suggestions to strengthen the fire protection system and interior design.

Arup's solution allows for seamless open plan designs to not only to be fully integrated with the most stringent fire safety regulations but also enhances the passenger's experience while retaining the aesthetics of the architectural design.

During the schematic design stage, we conducted fire safety analysis for the proposed scheme and proved that it meets required standards and regulations. As part of our analysis, we used computational fluid dynamics (CFD) to study the flow pattern of smoke to evaluate and validate the effectiveness of the proposed options of static and dynamic smoke control systems. We employed MassMotion, Arup's proprietary evacuation simulation software tool, to simulate human behaviour in an evacuation, and optimise the design of fire escape routes to give passengers the best chance of survival.

Fire separation without compromising on aesthetics

Instead of having floor slabs or fire-rated glasses to separate the platform from the concourse level, a virtual fire separation was proposed to enable an un-compartmented HSR concourse and platform

Large un-compartmented openings connecting the platform and the concourse level

design. This would also let in natural light from above while preserving the architectural feature.

The proposed virtual separation consists of a series of static and dynamic smoke control systems, including the trackside and platform mechanical smoke extraction system, connected atrium natural vent openings, plus the physical smoke separation, including the platform bulkhead smoke barriers and platform screen doors, concourse and atrium arcade smoke barriers. The escalators and stairs, including the large architectural voids connecting the platforms and floors above, are not required to be separated by fire shutters, therefore allowing for a porous design that facilitates passenger flow.

Robust smoke control design

The smoke exhaust design of the fire compartment of the public transportation links concerning the platform, concourse, seating areas and roof skylight employs natural smoke exhaust, which integrates with static operable windows to vent out smoke through the openings. The covered areas of the platform levels and other levels that are far away from the atrium are equipped with ceiling mechanical smoke exhaust.

The mechanical smoke exhaust on the trackside is installed with a separated smoke extraction system with tunnel ventilation fans at both ends of the tunnel as an air supplement system. This set-up can prevent the spread of smoke in the evacuation passages inside the building and ensure safety.

Progressive vertical evacuation strategy

The interchange concourse is in a single fire compartment but divided into separated egress zones based on functional and operational requirements. Various egress zones feature smoke-free stairs, open stairs, escalators, egress corridors and fire doors between the fire compartments as safety exits. Besides discharging to the street level as the ultimate point of safety, other areas such as the sunken plaza on the B1 level and the adjacent fire compartments can also serve as egress buffer zones to minimise the fire stair discharge points on the street level to maximise flexibility concerning the aboveground developments.

Overall, Arup proposed a zoned or progressive vertical evacuation strategy. This evacuation strategy includes a series of stairwells and escalators that lead from the platform up to a higher point in the station.

The lower floors are evacuated first, followed by the upper floors. This helps evacuate people from different sections of the station at different times, thus reducing congestion and panic.

In the event of a fire in one of the evacuation zones, a warning signal will be sent to adjoining fire compartments that a fire has occurred elsewhere to alert passengers through public announcements and fire alarms. In the area where the fire breaks out, a full evacuation will occur when the fire alarm activates.

The protected stairways on each level provide ‘fire sterile’ areas which lead to places of safety outside the station. Fire protection systems, such as sprinklers, smoke management and fire compartmentation, will provide tenable conditions in these areas for the time needed to evacuate the whole station.

Trusted expertise transforms HSR hub design

By proposing a comprehensive, coherent fire strategy customised to each multi-modal transit hub, we have proved to regulators, clients, railway design institutes and project teams that building a massive HSR station and hub underground could be as safe as building an underground metro station.

Since there are a handful of fire safety codes that all set different, sometimes overlapping, requirements, without a customised fire strategy like ours, multi-modal transit hubs could be over-equipped with evacuation routes, wasting valuable space and resources.

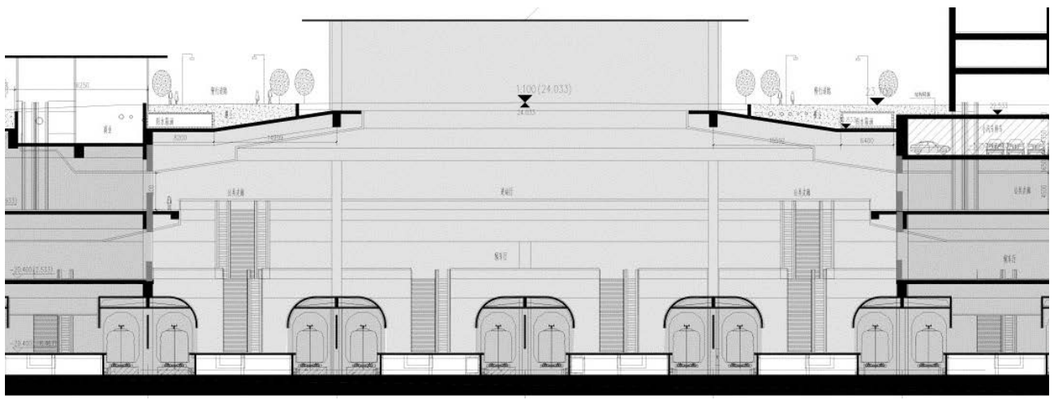
Our solution enables evacuation routes to be shared by different transit systems and different owners, thereby minimising provisions and facilitating emergency egress. These benefits are exemplified by the Beijing Daxing Airport Station project, now in operations, in which egress routes are shared by multiple transit systems within the same complex.

After fire engineering multiple large-scale multi-modal underground HSR hubs in China, including Shenzhen Futian station, Beijing Daxing International Airport station and this one, we have gained the trust of the rail authorities in us as an expert partner in the field of fire safety engineering.

Our fire strategy is transforming China’s underground HSR station design from standalone to the next-gen design that integrates multi-modal hubs, tall buildings, airports, and other mixed-use properties.

Apart from Beijing Sub-centre station, we are also working on Shenzhen Qianhai station, part of the master-planning work of Qianhai and Shenzhen Huanggang Port station with border crossing facilities that will connect with the Hong Kong rail network directly, and the Xili transportation hub in Shenzhen in which we have extended our services to include egress analysis and public safety study for the entire developments.

Relevant United Nations Sustainable Development Goals (UN SDGs)



Natural smoke exhaust is adopted for the atrium space, complemented by mechanical smoke exhaust at the track and other areas.

China’s first high-speed rail TOD built into city centre

Traffic and vertical transportation consulting for Chongqing Shapingba TOD


© Longfor Properties Ltd

Client:
Longfor Group

Arup’s scope of services:
MEP engineering, vertical transportation and traffic consulting services

After more than two decades of rapid urbanisation, China’s planning approach to transit-oriented development (TOD) has evolved to cater to the greater size and complexity of transit components. Now not only do TODs become larger, but there are also more underground rail types, i.e., local metro lines, intercity metro lines, high-speed rail (HSR) and airport express lines, not to mention the varied but important vehicular modes – from taxis and app services to shuttles, city buses and intercity coaches.

Shapingba station is China’s first multi-modal TOD built into the heart of a commercial district, which, prior to the redevelopment of the old Shapingba station, grappled with urban decay issues.

But the completion of Shapingba station as part of a landmark TOD represents one of the most aspirational regeneration programmes in Chongqing, giving the area a new lease of life.

Furthermore, as a major station on the Chengdu-Chongqing high-speed rail line, this TOD also contributes to the development of the Chengdu-Chongqing Economic Circle.

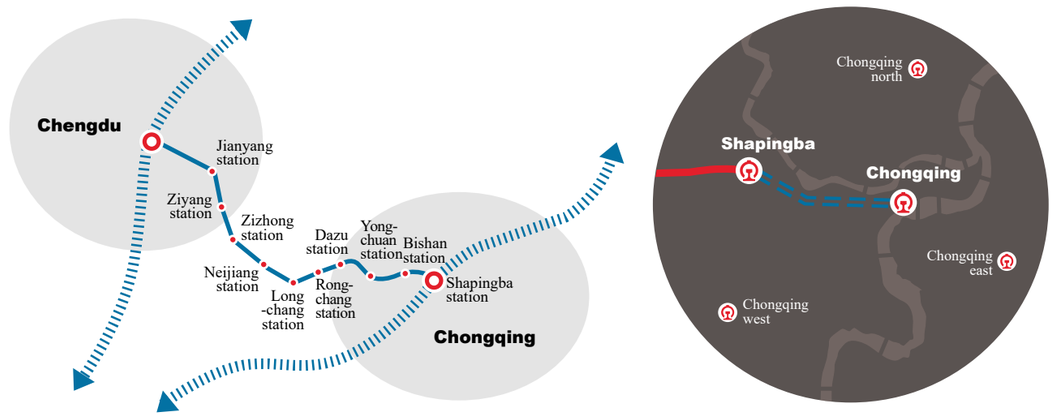
The success of the Chongqing Shapingba TOD exemplifies that large-scale multi-modal TOD that integrates with a mixed-use complex requires meticulous planning, including land use and transport planning.

During the planning stage, Arup played an important role in advising the client and project team on transport planning and vertical transportation strategies based on our analysis, enabling them to master-plan a continuous design that not only facilitates passengers’ walkability but also invites foot traffic to the commercial portion, i.e., the shopping centre – Longfor Jinsha Paradise Walk.

© Te Luo

The twin towers, including residential and retail spaces, rise above Shapingba station.

The HSR network connecting Chongqing to other cities in western China



Major HSR hubs in Chongqing and western China

The centrally located lift/elevator system serves all floors of the underground and aboveground parts of the building.

Section plan

G/F	Entrance, ticket office and security checkpoint
	HSR station, waiting room and ticket gate
B1	Access to Zhandong Road
	Bus stops, vehicular entrance to aboveground buildings
B2	**Side platform**
	Platform 1 Chengdu-Chongqing Passenger-Dedicated Line towards Chongqing (Chongqing station)
	Platform 2 Chengdu-Chongqing Passenger-Dedicated Line towards Chongqing (Chongqing station)
	Island platform
	Platform 3 Chengdu-Chongqing Passenger-Dedicated Line towards Chongqing (Chongqing station)
	Passing line of Chengdu-Chongqing Passenger-Dedicated Line (‘down’ direction)
	Passing line of Chengdu-Chongqing Passenger-Dedicated Line (‘up’ direction)
	Platform 4 Chengdu-Chongqing Passenger-Dedicated Line towards Chengdu East (Bishan station)
	Island platform
	Platform 5 Chengdu-Chongqing Passenger Dedicated Line towards Chengdu East (Bishan station)
	Car parking
B3	Car parking for social vehicles
B4	Transfer hall, HSR station entrance/exit that leads to ground or metro station hall
	Car parking for shared cars and social vehicles
B5	Car parking
	Access to Zhanxi Road and Zhandong Road
B6	Car parking
	Car parking
B7	Line 9 station hall
	Interchange corridor for Line 1 (below Sanxia Square) and Ring Line (below Tianchen Road)
B8	Circle Line platform

Building layout

With a total gross floor area of 480,000m^2, this project comprises an 8-storey underground transport hub and aboveground, a 7-storey shopping centre and six towers with heights ranging from 84m to 181m. Built directly above the station, the twin towers comprise residential and commercial spaces, including the Chongqing Longfor Jinsha Paradise Walk.

Cutting through multi-modal complexity

As the Chongqing Shapingba TOD has to cater to multiple transport modes, so the number of intermodal connections for riders. This presented challenges to conveniences, such as level changes, fare control and commercial opportunities. Likewise, the connections to the office towers, to other parts of the TOD and to the street, as well as the vertical transportation within, were highly complex.

One of the key challenges that arises from the convergence of multiple transport modes is the liaison with multiple stakeholders in charge of different functional aspects, including government agencies, railway bureau, local metro operators and commercial developers. The split in responsibility and land ownership among different stakeholders was challenging to resolve.

Drawing upon our extensive experience in delivering complex TOD projects across East Asia and especially mainland China and Hong Kong, we coordinated with various stakeholders to ensure smooth work progress. Our MEP engineers also carefully located the plant rooms and optimised system layout throughout the huge space – over 70m in height spanning around 700m.

Comprehensive traffic demand forecast

Forecasting traffic demand for the Chongqing Shapingba TOD, including a multi-modal hub connecting the HSR station, metro stations, bus terminal and taxi stand, estimating pedestrian flow among them was a complex technical challenge.

To address this challenge, by combining our research and statistics provided by the client based on its comparable TOD projects in Chongqing and other second-tier cities, we formulated a mix of models to forecast traffic demand, understand travel behaviour, find ways to reduce traffic congestion, optimise the use of resources in the entire development, and improve air quality.

Our transport planning team studied and analysed the area's urban structure and travel demand based on transportation surveys. Models were developed by examining the relationship between travel demand and exogenous variables such as socio-economic indicators. The future travel demand was estimated by entering the exogenous variables, i.e., socio-economic data such as population and employment, in the future into the estimated models.

Data from previous transportation methods were used to make forecasts of future travel using travel demand models, such as trip generation and production, attraction rates and demand allocation (modelling the choice between alternatives).

As well as analysing how people make travel choices, we input forecast data of population, land use and socio-economic conditions. The analysis was carried out under certain assumptions, which were based on benchmarking sensitivity checks.

Utilising these models, we carried out peak-hour traffic flow forecasts to stress-test the proposed transportation facilities and spatial design so that they would be optimised to meet the traffic load and streamline the interchange among different transport modes.

Arup adopted a passive design approach through air ventilation assessment and the use of eco-friendly materials to reduce energy consumption and improve thermal comfort in the atrium of the cultural centre.

Vertical transportation strategy

Armed with rational estimates of pedestrian volumes and demographic data, we applied different tools to determine pedestrian needs within the TOD environment. We employed MassMotion, Arup's proprietary software, to analyse and visualise foot traffic and explore different pedestrian traffic scenarios within the public spaces, including the HSR and metro stations, transport hub, shopping centre, etc.

Then, we developed an innovative vertical transportation strategy that integrates escalator and lift/elevator usage forecasts with outdoor traffic flow forecasts, optimising the daily operation of the entire development.

Maximising rental value by attracting footfall

Arup's transport planning and MEP teams helped the client and the project team determine the economic and technical viability of the project and mitigate risks for investments in the planning process. For example, different types of passengers have different behaviours and needs at different places and times.

Apart from ensuring passenger comfort and safety, the vertical transportation design we provided was optimised to drive footfall to the retail space, so that the client could effectively build a strategic and successful tenant mix.

Another highlight is the canopy of the cultural centre in the development, for which we provided a passive design approach. Combining results from on-site testing of existing retail and CFD simulation, thermochromic glass and aluminium panels were adopted to reduce energy consumption and improve thermal comfort in the atrium.

Implications for future TODs in China

When planning a new multi-modal TOD, a carefully performed comprehensive study, including traffic analysis, demand forecasts, as well as socio-economic and environmental impacts, is recommended.

A preliminary study can help maximise ridership and optimise land use mix, therefore land value. When armed with rational demand and ridership forecasts, private developers can work out a valuation model to assess the maximum value they are willing to pay for the development site, optimise the spatial design and vertical transportation strategies, and mitigate risks.

Many Chinese cities now proceed towards building and redeveloping rail transit systems to transform cities. Through a more holistic transit-oriented town planning approach, local governments can explore more innovative financing or value capture mechanisms, which, when used effectively, can support the sustained growth and maintenance of China's growing rail network infrastructure.

This is where Arup comes in: we offer fully comprehensive planning of TOD and transit-oriented cities, with special emphasis on promoting sustainability, resilience and liveability while addressing economic viability.

Relevant United Nations Sustainable Development Goals (UN SDGs)

Hong Kong's iconic Peak Tram

Preparing for 'Peak' traffic

The Peak Tram is Hong Kong's most historic and iconic transport system that serves the Peak, a world-famous destination, including the Peak Galleria, a retail and leisure complex.

Since 2017, Arup has been appointed by their owners to improve their design to accommodate more passengers and tourists while achieving a more seamless passenger experience.

Client:
Peak Tramways Company Limited (PTC), Hang Lung Properties

Arup's scope of service:
Transport consulting

Locations of Lower Peak Tram station (pinpointed) and St John's Building

Peak Tram upgrade

In 2017, Arup's Transport Consulting team was appointed by Peak Tramways Company Limited (PTC) as crowd simulation modelling consultant to review and advise on the queuing arrangements and space provision for the Peak Tram upgrade project while Arup's Civil Engineering team was working on ground investigation, geotechnical assessment of the Lower Terminus as well as civil works design in the passing loop area.

Following these works, we were also appointed by PTC to take on a structural design commission from a previous consultant for the difficult and highly constrained work of extending and upgrading the Lower Terminus. This work will significantly improve passengers' experience before boarding the new and larger tramcars by providing an inclined and fully enclosed travellator section plus larger platform and waiting areas.

Our Transport Consulting team provided comprehensive and feasible boarding and alighting arrangements and queuing strategies based on various surveys, video analytics and visitor flow simulation modelling analyses at both the Upper and Lower termini.

Based on a comprehensive visitor flow simulation, including an analysis of the increased tram capacity and the new arrangement of the new termini, we optimised the Lower and Upper Termini designs.

We also suggested crowd management measures based on various simulation modelling scenarios. Our study was adopted to support conceptual and detailed designs, which were approved for construction.

Need for increased capacity

Before the pandemic, the Peak Tram's popularity posed a great challenge to the operator as demand at peak times far exceeds its capacity, resulting in long queues outside of the Lower Terminus.

According to PTC, passengers had to wait up to two hours during peak hours. PTC realised the need to increase passenger capacity after securing a ten-year operating right until 2025.

After government approvals, the capacity of the Peak Tram would be increased to 210 from 120, which would reduce waiting time by 75-91%, from about 90 to 17 minutes during peak hours on weekdays, based on estimates in 2018.

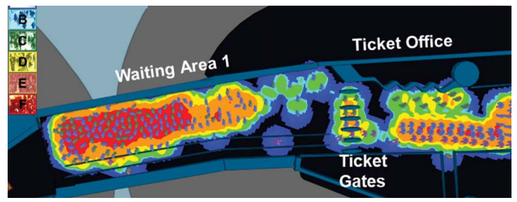
According to PTC, passengers had to wait up to two hours during peak hours before COVID-19.

Covered, air-conditioned queuing and waiting areas would also be built to accommodate 1,300 pax at the Lower Terminus. Therefore, the boarding and alighting platforms would be relocated to some 70m uphill, creating an extended Lower Terminus extending down to St John's Building.

Meanwhile, the Upper Terminus platform area was proposed to be renovated, including widening the boarding platforms, increasing the number of turnstiles and points-of-sale, and enlarging the waiting area before ticketing.

Harnessing the power of simulation

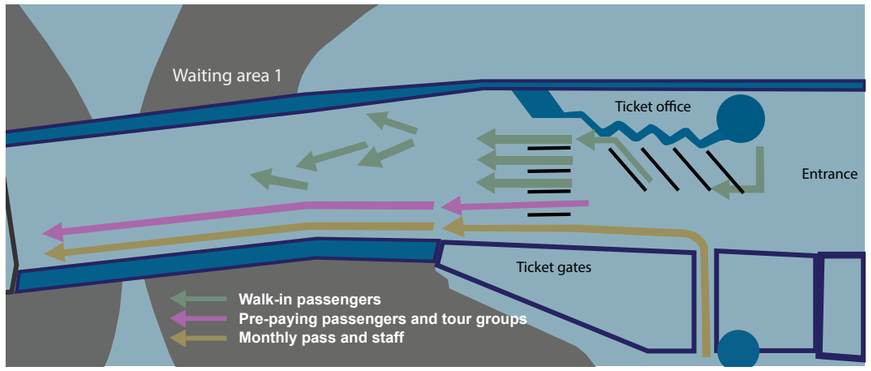
We carried out various site surveys, adopted advanced video analytics and simulation modelling analyses at both the Upper and Lower termini to



We developed 3D pedestrian simulation models to stress test the station design and queuing capacity under different scenarios.

identify a robust and flexible queuing strategy to utilise the limited queuing space fully. Passenger experience and safety can therefore be enhanced while achieving effective operation of the Peak Tram. We also assisted PTC in conducting numerous experiments on the previous terminus, such as signage and direction guide labels, to shorten the boarding and turnaround times.

During our study, we developed 3D visitor flow simulation models to stress test the terminal design and queuing capacity under different scenarios



In our design, pre-paying and walk-in passengers are separately handled by two waiting corridors.

factoring in all passengers from different ticket groups, such as walk-in and pre-paying passengers, level of service in waiting areas/at ticket gates, and peak/off-peak periods in order to optimise the design of the Lower Terminus.

The level of service is an essential aspect of terminal design. It is one of the most influential factors in deciding the passenger's satisfaction and is critical to the Peak Tram's reputation as a memorable tourist attraction.

Using Arup's proprietary MassMotion software, we developed a model to stimulate passengers' aggregation behaviours in both termini's waiting and holding areas. Since tramcars run at a frequency of 8-10 minutes, we ensured the design of the holding and waiting areas could handle both alighting and boarding passengers within this timeframe.

In our design, pre-paying and walk-in passengers are separately handled by two waiting corridors so that pre-paying passengers could have a higher priority. It also encourages repeat visitors to purchase tickets online.

In addition, our simulation also illustrates the priority of different crowd management measures that can be used to improve the level of service. The upgrade project commenced in mid-2019 and is scheduled to complete in 2022. During this period, services were suspended for some months to allow work to be carried out.

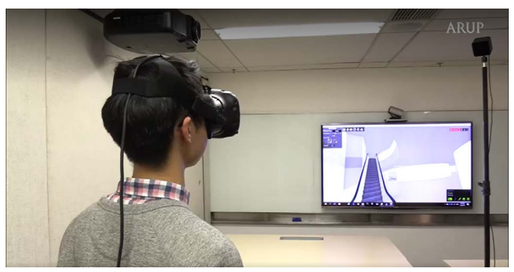
Optimising signage visibility and placement for Peak Galleria

After getting off the Peak Tram, most visitors and tourists would be impressed by the Peak's spectacular views and spend some time taking photos. As with other tourist destinations, they would enjoy a meal and do some shopping before leaving. Given that tourists' time is valuable and that their word of mouth is vital to the reputation of the Peak, it is important to leave them with the best shopping experience by enabling them to navigate the shopping mall smoothly.

When asked by the client to review and improve the signage system of Peak Galleria, we proposed to utilise a signage visibility analysis and optimisation system based on an updated BIM model of the building and MassMotion, Arup's proprietary crowd and pedestrian simulation engine, to simulate the movement of shoppers, i.e., agents. With an as-built virtual environment, the model was updated with geometry definitions of different navigable zones and spaces and models of fixed assets. By adding obstacles, possible visual obstructions were considered.

The simulation model contains algorithms, functions and pre-defined scenarios to calculate the coverage and the visibility of the shopping mall's signage system, allowing the Arup team to analyse the efficiency of signage, including type, content, font type, colours and size, visibility distance, orientation and comprehension time, visualise them in a virtual environment, and optimise their placement and design.

Improving the efficiency of signage system design has always been a challenge for designers, planners and building managers. But our solution,



Arup utilised a simulation model to analyse and optimise the placement and design of Peak Galleria's signage system.

Arup's wayfinding simulation solution can help planners, architects, and designers create signage systems even during the design stage. Pictured is the Peak Galleria shopping mall at the Peak, Hong Kong.

which combines VR, BIM and agent simulation capabilities, can help planners, architects, and designers create signage systems even during the design stage. The simulation model can further help build a Variable Message Signage (VMS) system that allows the building manager to send messages or alerts, such as instructions on evacuating the building during an emergency.

Our wayfinding simulation model can also be applied to complex environments like airports, museums, hospitals and metro stations. Apart from the simulation model we developed for Peak Galleria, we are working on another simulation model to improve directional signage at metro stations. Considering flows and behaviours of passengers under different scenarios, the system assesses signage visibility and identifies whether the signage placed in stations displays contradictory information.

The way forward

As can be seen, traffic modelling and crowd simulation is one of the most powerful tools we use in transit and road and building infrastructure design. At Arup, not only have we developed MassMotion, but we also make use of a wide range of software tools for traffic analysis and apply a multi-model approach to make our analysis more reliable and the results more defensible.

Combined with our expertise in lighting and wayfinding system designs, our comprehensive transport planning solution can analyse traffic situations scientifically to eliminate congestion, reduce delays, improve road and passenger safety, and most importantly, offer a pleasant experience to passengers/visitors.

The current signage system at Peak Galleria is the result of Arup's way-finding simulation work.

Relevant United Nations Sustainable Development Goals (UN SDGs)

Note: For the record, Arup was the original structural, building services and façade engineer of The Peak Tower in 1997 and provided consultancy services for the alteration and additional works, including structural, building services, wind, façade and fire engineering design, in 2006.

Think from the ground up

James Sze

James Sze, Leader of Geotechnics, Maritime & Energy Group at Arup in Hong Kong, gives an account of how he has overcome difficult ground conditions since joining Arup in 1995. For him, the process of discovery and reflection is a joy.

While James has taken a broader leadership role in managing a large team of multidisciplinary talent and overseeing a diversity of projects in recent years, his passion still runs deep through his veins and blood.

What really keeps him on the ground is the variability in strength he encounters. “Though Hong Kong is a small city, we do have a large population of geotechnical engineers to tackle engineering problems, ranging from stabilising hilly terrains to reclamation in the sea, and to deal with a variety of ground conditions from toothpaste-like soft deposits to hard rock, and everything in between.”

Early career

After graduating with a civil and structural engineering degree in 1994, James had a stint with a specialist foundation contractor, which provided him with the necessary hands-on experience about the groundwork, especially the buildability consideration behind a good design.

“Don’t confine yourself to the attitude ‘that’s how it’s always been done’. We should always remember that codes and standards do not replace scientific judgment and real-world experience.”

At Arup, he has taken a hands-on and in recent years a leading role in various aspects of infrastructure projects, including site investigation planning, land study, reclamation, pile study, foundation design, site formation, slope inspection, slope stability assessment, retaining wall design, tunnelling and deep basement excavation, lateral support design, and site supervision work.

One of his earliest projects with Arup was the pile design for the Bangkok Elevated Road and Train System project in Thailand which embraced a pile testing programme. “As an inexperienced engineer that time, it was fun to supervise test pile construction and instrumentation, training local technicians in conducting full-scale loading tests, and analyse field results simultaneously next to a railway with trains passing by under a hot weather,” he says, adding that the knowledge of utilising post-construction grouting in enhancing pile capacity gained from this project in a weak ground was re-applied to other Arup projects in Hong Kong and other Asian cities.

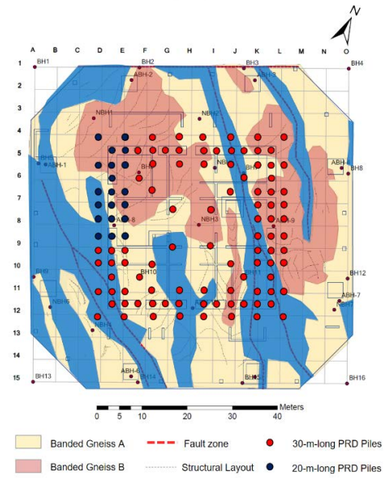
Challenging ground conditions

One of the key projects that he has worked on to illustrate the capabilities and out-of-the-box thinking of his team has been able to test and implement is Lotte World Tower in Seoul, South Korea. Rising to over 555m, the 123-storey super-tall building is the tallest in South Korea and the fifth tallest in the world.

The supertall tower is underlain by multi-directional faults and shattered rock mass. “There were debates among the client’s in-house teams over whether the ground conditions were favourable or require considerable treatment to withstand a gravity load as high as 6,700MN.”

During the discussion, James convinced the client that, with simple calculations and overseas case studies, the fractured rock mass has a capacity well above the need and the only worry is the uncertain variety of the ground. Despite this uncertainty, James assured the client that the team could make the best estimate on the ultra-complex geological condition based on the available borehole and testing data.

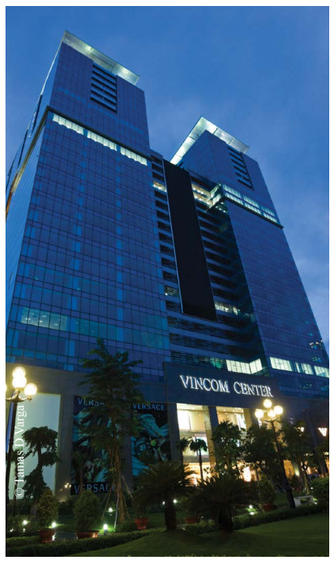
In the end, Arup’s proposal for a cost-effective hybrid solution of piled raft foundation was adopted by the client. The raft would provide overall foundation capacity and the strategically placed short piles to mitigate the potential differential settlement at the concerned portions of the tower. James represented Arup at a press conference to explain to the public the foundation design of this landmark project.



Piled raft foundation design for Lotte World Tower

Laying the foundation for super-tall buildings is one challenge, digging down for deep basements is also no easy task. For Vincom Centre in Ho Chi Minh City, James' team was involved in a deep basement construction in soft clay. Though basement construction has been developed for many years by using either top-down or bottom-up construction techniques, digging deep underground to accommodate a basement of six storeys for this project requires excavation to up to 30m, the deepest in the city, which is no easy task.

Consequently, a high-capacity shaft grouted barrette foundation and a 1.2m thick diaphragm wall were designed to support an unusual semi top-down construction sequence of the basement to achieve a fast-track construction and eliminate the need for expensive steel stanchions over the basement zone at the core walls.



Vincom Centre, Ho Chi Minh City

Calculated innovations

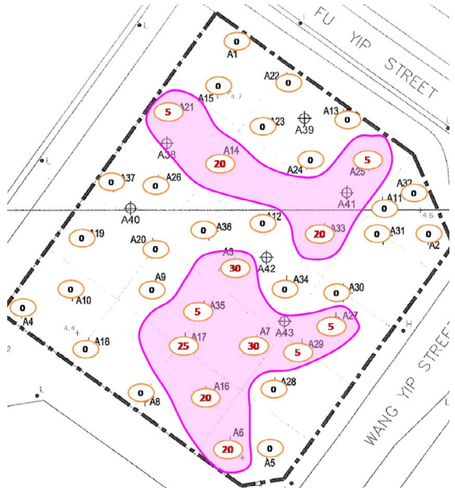
Despite its modest size, Hong Kong is characterised by its complex and varied geological conditions. "The process of investigating a problem specific to a site and developing a solution that works is rewarding," he says.

One case he cites is the International Commerce Centre, which is built on a site underlain by a depressed rockhead that may be attributed to a geological fault, rendering the normal end-bearing piling system non-viable. Following a series of detailed studies and comparisons of various foundation types led by Arup Fellow Dr Jack Pappin, shaft grouted friction barrettes were chosen and implemented successfully.

"If Hong Kong's tallest building doesn't require piles to be founded onto sound bedrock, I hope our engineers do not take conventional end-bearing piles as a default scheme – it's not engineering."

In the New Territories of Hong Kong, Yuen Long's geological conditions are characterised by the existence of cavernous marble formations. In 2012, the Hong Kong Housing Authority commissioned Arup to conduct a study on a proposed Home Ownership Scheme housing site, which revealed the existence of buried marble and karstic cavities at various depths underneath.

"Contrast to the original plan of building residential towers taller than 30 storeys, due to the difficult ground conditions we recommended the client candidly that the buildings be no higher than 11 storeys at most. Rather than a pile foundation solution, we devised a cost-effective buoyancy raft foundation, also known as cellular raft or floating foundation,



Marble scoring indicates a 'very difficult' site condition.

to underpin the buildings on weak soils and to control the stress level at the underlying cavities within an acceptable range."

The floating foundation is typically adopted for low-rise structures. "However, we convinced the client to adopt such scheme as its first. The solution we proposed managed to underpin two medium-rise affordable buildings for HOS buyers. Though this project is not as iconic as those super tall buildings, for me, the discovery process is exciting and challenging."

Understanding what the rulebook means

"In engineering, codes are like a bible. But as codes have evolved, they have become increasingly difficult to understand and use. In some countries, seismic codes are unnecessarily conservative, which may not necessarily increase the safety of structures, but are prone to hinder construction work."

For Crescent City & Crescent Place, which consists of high-rise residential and commercial towers, in Azerbaijan, Arup provided the geotechnical engineering designs for the prestigious development abutting the seashore of the capital. Arup's original scope of services had not covered the construction stage, but it was extended after the discovery of the poorly performed trial pile and basement excavation on site. At the client's request, James was asked to provide the construction stage advice service by guiding site technicians on the proper construction method and the right sequence of works.

"Separately, realising that the country's seismic code is overly conservative, we convinced the client, through comparison of design practices in various countries, to follow international standards in order to achieve a more rational foundation and superstructure design."

> "My sense is that rules should not be blindly followed without understanding what they mean and what their impacts are."

Crescent City & Crescent Place, Baku

The construction of cross-boundary passenger terminal building of Border Control Facilities at the Shenzhen Bay Port was entrusted to the Chinese authorities, but the design of the southern half of the building needs to comply with the Hong Kong standard.

Due to the newly reclaimed land and conservative specification promulgated by the Hong Kong government department overseeing the Hong Kong portion, the resultant foundation design turned out to be excessively conservative, which would pose a stark contrast to the opposite side of the same building administrated by the mainland counterpart," James recalls.

To address this discrepancy, James initiated a discussion with the concerned authorities in efforts to relax the relevant clauses specified in the standard by providing justifications based on published research papers and detailed analysis. These efforts resulted in a 20% reduction in precast prestressed reinforced concrete piles.

Debate if you have grounds

"When I was young, I read plenty of research papers to find out what the rules are intended to

James (left) performed a tunnel inspection with the MTRC team at Hong Kong Express Rail Link.

achieve. My advice for young engineers is that don't confine yourself to the attitude 'that's how it's always been done'. We should always remember that codes and standards do not replace scientific judgment and real-world experience. Tunnelling project is a classic example of how experience and judgement need to be exercised to ensure its successful implementation."

"As long as you have done enough research to support your argument against the rationality of a rule, you should engage in debate and challenge conventional thinking. Being able to convince others with a solid grounding is a joyful life experience."

Expertise gains recognition

Felix Ma

Felix Ma, Arup's Director and China Cities and Advisory Group Leader based in Shenzhen, explains why industry leadership and expertise go hand in hand.

Felix Ma has broad experiences with design and management, especially anti-seismic and anti-wind design of complex buildings. His extensive experience in Hong Kong and mainland China projects has enabled him to manage multinational teams in delivering projects. What we learned from Felix's leadership is that consistently delivering excellent works can win the recognition and trust of clients.

"To give clients confidence, we must deliver consistent, reliable works at all times. Yet, to gain their respect, we have to deliver excellent works that not only address their key challenges but also exceed their expectations," he says. "Being a pioneer is hard, but this is the pathway to industry leadership."

Shenzhen: a city of opportunities

Born and growing up in northern China, Felix began his career at the Fushun Architectural Design Institute after graduating from Tianjin University in 1990. In 1996, he joined Arup's Shenzhen office as a structural engineer. "In the 1990s, China was about to undergo a building boom. Opportunities abounded for engineers and building professionals. Among the four first-tier cities, Shenzhen has a vibrant culture that is most welcoming to talents from all over the country."

In the first few years with Arup, Felix was mainly involved in structural design works of Hong Kong projects. He was later involved in transit-oriented development (TOD) works in Hong Kong, Singapore and Shenzhen.

Reaching new heights

"After ten years of playing my role as a structural engineer, I realised that I wanted more possibilities. To advance my career, I had to step out of my comfort zones. Therefore, I challenged myself to take up more senior roles to oversee projects that require cross-disciplinary collaboration."

The key projects for which Felix acted as the project director include the Zhengzhou Yinji Central Plaza complex development project, which comprises the tallest building in Zhengzhou; the Shenzhen Metro Line 3 East Extension property development and financing scheme study; and the Hengqin checkpoint complex.

He also oversaw the design and implementation of various office projects, including Shenzhen Shimao Qianhai Financial Centre; Dongguan International Trade Centre, a mixed-use development containing the tallest building in Dongguan; Jinzhou International Hotel and Exhibition Centre, a mixed-use project comprising the tallest building in Jinzhou for which Arup is the lead consultant; the Foshan Cultural Complex project for which Arup is the lead consultant; and the East Pacific mixed-use development in Shenzhen.

Standing at 300m in height, the award-winning Shimao Qianhai Centre is the tallest twisted building in China. The tower is formed by four double-curved façades featuring a 45-degree twisting structure. An innovative twisted frame-core wall structure system was developed to realise the building's unique spiral shape.

"The architecture team was very impressed when we were unfolding the design drawn on a scroll of tracing paper. It was said to be an eye-opening design. After a three-day workshop, we were held with high regards for our innovativeness, and the architecture team strongly recommended us to the client."

Another achievement Felix is proud of is the structural design of Dongguan International Trade Centre, which rises to 440m tall. Designed and completed on a fast track.

With effective design coordination and innovative design development, the schematic design process undertaken by Arup lasted one and a half years. "Though only three Arup members were involved, we did our part very cost-effectively, without compromising on quality."

Shimao Qianhai Centre is the tallest twisted building in China. The team led by Felix developed an innovative twisted frame-core wall structure system to realise the building's unique spiral shape.

> "To gain clients' respect, we have to deliver excellent works that not only address their key challenges but also exceed their expectations. Being a pioneer is hard, but this is the pathway to industry leadership."

Respected for thought leadership

In China, the structural engineer is usually engaged by the architect to design a proper structure that fits into the architectural design. However, for the East Pacific project – which comprises China's tallest twin residential towers when it was built – the client reached out to Arup in the first place and told of their vision to build a high-rise mixed-use complex.

"But they had hesitation on concerns that strong typhoons would cause a tall building to sway. Inhabitants would complain of seasickness if the building sways too quickly," Felix recalls. The team eventually worked out a reinforced concrete structure that could support two 300m residential towers. "They took our advice and decided to include residential towers in the scheme."

The team led by Felix worked out a reinforced concrete structure underpinning the two 300m residential towers of the East Pacific project.

Seeing the full picture

Jinzhou International Hotel and Exhibition Center is an award-winning staggered block building in Guangzhou. It is also the first project for which Felix managed over ten disciplines. "Leading a multidisciplinary team is the core of where you will gain most of your improvements and success," he says.

"As the project manager overseeing the works of project team members from more than ten disciplines, including six from Arup and the rest from external parties, it was a tremendous challenge. But this also represented an opportunity for me to gain a granular view of the entire project development lifecycle by connecting dots and lines to form a full picture."

Impressed by the aesthetic and functional designs, a world-famous exhibition organiser reached out to Arup a few years after the exhibition centre had been in operation. "We had a few discussions in Shenzhen and Hong Kong for future co-operation opportunities. I realise that even though the project is in a lesser-known location, as long as it is built to a world-class standard, it still attracts the world's attention."

Planning for future cities

Now serving as Arup's China Cities and Advisory Group Leader, Felix was involved in a consultancy project for Shenzhen's Qianhai District to prepare the local government for upcoming works on infrastructure programming and implementation, urban industry planning, design, planning, engineering consulting and design management.

Equipped with excellent presentation and communication skills, Felix was designated as the tender presentation leader. Convinced and impressed, the evaluation panel decided to award Arup with the contract about two hours right after the presentation.

Tectonic shift in China's planning policy

It is reported that China's National Development and Reform Commission prohibits the approval of new buildings taller than 500m and strictly limit buildings taller than 250m while requiring any building taller than 100m to match the spatial scale of the city and comply with local fire and rescue capabilities.

Felix believes this new agenda signals a watershed moment in China's urban planning strategy. "Bigger no longer means better. That's the viewpoint of policymakers. Rather than allowing skyscrapers to pop up, I believe that the Chinese government is gearing urban planning towards being more sustainable, greener and smarter. Buildings should be planned as part of a city, instead of being planned in a piecemeal fashion like before."

While tall buildings that rise to 400m or 500m into the sky are imposing, they may not maximise energy and space efficiency, given the existence of refuge floors being left empty most of the time and that vertical transportation and HVAC require a sentential amount of energy consumption to keep them up and running, he explains.

"In hindsight, China's rapid urbanisation has come at the expense of our natural environment. Policymakers are now demonstrating a strong will to drive urban development towards the goal of doubling carbon capture capacity by 2030/2060."

Advice for young engineers

"Throughout my career, I've always been open to new opportunities and challenges, proactive in guiding my development, and taking on new roles which have pushed me outside of my comfort zone, enabling me to have a diverse range of roles and experiences."

"My advice for young engineers is that put your hand up to give new roles and responsibilities a go when opportunities emerge. Seek to learn, develop and improve your technical, professional and presentation skills. Be a team player. Most of all, strive to deliver your best. Over time, you'll gain the recognition and trust of your team and clients."

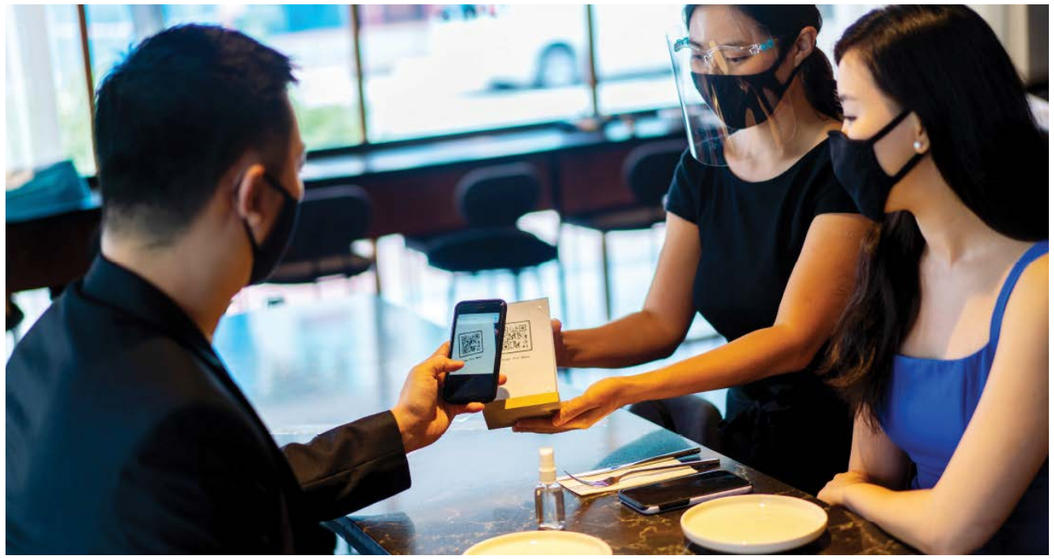
Felix was speaking at the MoU signing ceremony for strategic collaboration between the Nansha government of Guangzhou and Arup.

"Throughout my career, I've always been open to new opportunities and challenges, proactive in guiding my development, and taking on new roles which have pushed me outside of my comfort zone, enabling me to have a diverse range of roles and experiences."

Graduate Induction Programme 2020

Over the years, Felix has worked closely with and built a good rapport with Hong Kong colleagues.

Felix at a get-together in 2007 in Hong Kong (pictured above) and a Design School class organised by Arup University in 2004 (pictured below).



COVID-19 has pushed malls and shops to go much more online.

Hybrid Retail Asia: four plausible scenarios

A new Arup report explores four plausible scenarios on the future of the retail sector at the intersection of consumer motivations: enjoyment, control, power and belonging.

The unprecedented global health crisis has a profound impact on the way people shop.

As the retail landscape continues to evolve, it is of utmost importance for brands and retailers to adjust their strategy to stay relevant and competitive. Thanks to technological advancement, they increasingly combine in-person and virtual experiences to form what is known as hybrid strategy to engage with customers better.

We have published an in-depth report to explore the tectonic transformation of retail space into a diversified destination where people come to not just shop and dine but also to meet and greet and share a special experience. Some retailers are seeing success with this hybrid strategy, but there is a gap in understanding how to make them work together.

To address this gap, this report helps industry stakeholders, such as developers, architects, and designers, as much as policymakers, brands and retail operators, understand the market drivers, challenges and trends and explores how successful retailers and shopping malls are leveraging this strategy to drive customer engagement and revenues.

Key takeaways

– Retailers and mall operators are recommended to build resilience to unforeseen disruption

– For retailers, they should understand the key drivers of change in the sector where they operate

– Understanding the phenomenon of digital disruption beyond the buzzwords is important

– Omnichannel, consistent message and flexibility are key to success

– Optimise the way customers consume by providing a data-driven, personalised experience

Citing official statistics, the report examines the changing behaviours of Asian consumers and how key drivers such as demographics and levels of urbanisation combined reshape the markets. To meet their new expectations, brands are realigning their strategies and updating their offerings with innovative solutions to deliver engaging and tailored user experiences.

The report goes on to explain how shopping malls and outlets across Asia have been repositioned, redesigned or reconfigured to respond to changes in customer behaviours and brands' strategies. Ultimately, it has to be acknowledged that effective future mall design needs to consider proper spatial design to establish its own image as well as to blend well into its surroundings and serve local communities. Retail establishments should be well considered on a city-planning level and embedded seamlessly with the public.

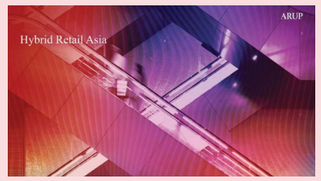
The summary of the report explores four future plausible scenarios where brands, retail space and community meet people's motivations.

Cashless checkouts will see a huge push forward for retail in the future.

Accordingly, the four plausible scenarios are:

- Anytime, anywhere
- Seamless encounter
- Stage retail
- Hybrid living

This work is the result of a collaboration between Arup University, Arup teams across the East Asia region and external contributors.



Download the report

East Asia Ventures TechConnect Series

As a leading multidisciplinary consultant, we know that to stay ahead of the curve, we need to drive innovation. To do this, we adopt an open innovation strategy by working with external start-ups to co-create solutions that are tailored specifically for clients while emphasising on sustainability.

Organised by Arup University, the Ventures TechConnect Series invites tech entrepreneurs from around the world to share their innovative solutions to critical challenges facing the built environment with our staff members. The objective is to facilitate collaboration opportunities between tech start-ups and Arup and draw inspiration from potential external partnerships.

Objectives of TechConnect:

- Keep up with technological trends
- Identify how they may benefit our clients
- Co-create solutions
- Form long-term partnerships

One key role of Arup University is to scan new trends and build relationships with incubators, accelerators and angel investor networks in cities with strong start-up ecosystems e.g., Hong Kong, Singapore, Tel Aviv, Shanghai and Shenzhen. Innovative ideas of their portfolio companies are then introduced to different Arup teams allowing project teams to identify when and where they can use these technologies.

Featured start-ups

OceanAlpha specialises in USV (Unmanned Surface Vehicle) development for water environment sampling and monitoring, mapping and hydrographic surveys, and bathymetry. In October, Ran Zhang, the company's general manager of international business, delivered a talk to Arup teams.

XtreeE uses six-axis robotic arms connected with a single nozzle to deposit the material. It has printed the entire load-bearing deck for a 40m-long footbridge in the recent past, said Nicolas Ducoulombier, an R&D expert of XtreeE, during a talk to Arup in August.

OceanAlpha's unmanned surface vehicle

Geometrid is a Software as a Service (SaaS) for progress monitoring and element tracking across the supply chain on construction projects. Milos Jovanovic, the company's founder and CEO, talked about how a cloud-based construction management platform could drive speed, efficiency and accuracy at each phase of the construction project lifecycle in June.

Dayta AI's game-changing product, Cyclops, is a cloud-based AI retail/property analytics solution that can utilise CCTVs to acquire, evaluate and interpret

The XtreeE multi-component 3D printing system can be mounted on robotic arms, caterpillar or gantry systems.

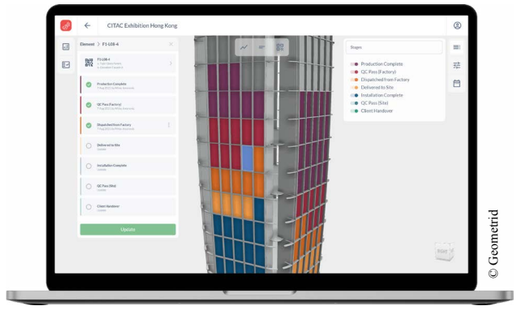
in-store visitor traffic/demographic/behaviour data. In May, Patrick Tu, Dayta's CEO and founder, presented their vision and use cases in building management systems.

In May, Ivan Cheung, product director of Mapxus, was invited to share his company's intelligent, seamless, scalable and sustainable indoor geospatial technology and solution that create digital directories for indoor space navigation.

Formed by the Hong Kong University of Science and Technology (HKUST), University of California, Berkeley, and Tsinghua University in 2020, Hong Kong Centre for Construction Robotics (HKCRC) is on a mission to bring robotics, AI, and other advanced technologies to the construction industry.

In a talk held in November, two speakers from HKCRC shared their latest research results with us online. Dr Haobo Liang, an HKUST alumnus, provided participants with a high-level introduction to HKCRC. Dr Yixin Yuan, an MIT alumnus, shared his current research into automated inspections on prefabricated components used in modular integrated construction (MiC) at HKCRC.

Arup University actively encourages and supports innovation by collaborating with leading technical institutes and universities and by working with innovative start-ups to enhance our capabilities and create new value for our clients.



Geometrid provides a Software as a Service (SaaS) platform that enables construction project management.

How can developing cities improve transport mobility?

Urban mobility best practices and applications adopted by four high-density cities in developing countries

In this study, we looked at how developing cities can improve the efficiency of public transportation while optimising car ownership through innovation. Four densely populated cities in four developing countries were studied to understand the demands for and benefits of smart mobility. As part of this research project, a mobility innovation toolkit that captures the lessons learnt from these cities was developed and disseminated across Arup to support our teams to guide transportation clients and stakeholders on their project journey.

Bogotá, Columbia

Population (2018)

7.2 million

In the 1990s, the public transport system in Bogotá, the capital of Columbia, was overloaded and therefore the government developed one of the world's most successful Bus Rapid Transit (BRT) systems, under the name of TransMilenio. Today, TransMilenio consists of several interconnected BRT lines, with raised floor stations in the centre of the main avenue, or 'troncal'.

As Bogotá's BRT lines continued to compete for passengers in the infamous 'war of the penny', the need for a more unified solution grew. The administration eventually managed to get the Metro project to the bidding stage in October 2019 after a decades-long debate. A Chinese company won the bidding and broke ground in October 2020.

Bogotá's first car-free day was first organised in 2000 and since a large part of the city's streets is free of cars every Sunday. This year, it pushed for the car-free day to be extended into an entire car-free week. The first-ever Bogotá car-free week was held in February this year. The experimental event has prompted national discussions of making Bogotá a leading bicycle city while keeping car ownership low (75% of Bogotános live without a car 365 days of the year).

The Salitre El Greco TransMilenio station on Avenida El Dorado, Bogotá.

Metro Manila, the Philippines

Population (2018)

13.5 million

The city's existing public transport system relies primarily on jeepneys. But with a rapidly growing economy, the Philippines has been seeing rapid car ownership growth in recent years – one of the fastest in the ASEAN – without major infrastructural upgrades over the same period. This trend is causing severe congestion and air pollution, posing a severe risk to the country's overall social and economic development.

To address these challenges, the Philippine government aims to develop a reliable, attractive and cost-effective public transportation system under its 'Build, Build, Build' programme. The South Commuter Railway Project, also called PNR-Calamba, is a key component of the 147km North–South Commuter Railway system that will reshape the country's transportation network.

The railway project is part of Asia Development Bank's (ADB) business plan for the Philippines. It links to another ADB-funded railway, the Malolos–Clark Railway Project, a modern, elevated railway line that will connect northern provinces to Metro Manila. Within Metro Manila, the Metro Manila BRT Line 1 project is being planned and expected to commence construction in 2022/2023.

Ho Chi Minh City, Vietnam

Population (2018)

8.9 million

In Ho Chi Minh City (HCMC), private motorcycles are the main means of transportation. However, the negative effects of a large number and high concentration of motorcycles in urban areas have resulted in a shift in the public's opinion of private vehicle adoption, especially motorcycles.

In response, the city's government has set a vision to increase the share of public transportation to 30% in 2030 from 10%. To realise this vision, alternative means of transport are now under development or being introduced. Along with the promotion of less-polluting vehicles such as electric motorbikes and buses, HCMC's first metro line No. 1 is now under construction and expected to commence operations in 2022. A few more metro lines are also being planned.

Despite the ambitious plan, HCMC's transportation system is vulnerable to monsoon flooding and storms. Therefore, it is imperative to incorporate resilience in the approach to the city's transport planning.

Xiong'an New Area, China

Designed to accommodate a population of about

170,000 (as of 2021)

In 2017, China announced plans to establish Xiong'an New Area, located about 100km southwest of Beijing, aiming to build an area of 1,770km^2 into a green, smart city that will set an example for the rest of the country. Over the past four years, construction works have been in full swing, including infrastructure construction and ecological restoration works.

An intercity railway linking Xiong'an and Beijing started operation in December 2020, slashing the commuting time between the two cities from one and a half hours to about 50 minutes. Meanwhile, the construction of three express lines linking Xiong'an, Beijing and the neighbouring Tianjin Municipality was open to traffic in May 2021.

As early as 2019, Arup was commissioned to provide recommendations on Xiong'an New Area's transport development planning based on international experience and perspectives. The areas of recommendation include integrated and inclusive infrastructure; user-oriented services; innovative technologies; and green transport.

Impact of COVID-19 on urban transport

In September 2020, Arup interviewed representatives from cities across the globe to understand the pandemic's impacts on transportation.

COVID-19 has led to significant changes in the day-to-day operations of cities. Mobility has been severely restricted to slow the spread of the virus, and this has proved to be successful. Cities are now starting to ease the restrictions, allowing people to return to work and resume some social activities. However, this can lead to new waves of infections, especially in regions with a heavy reliance on highly utilised public transport services.

As cities are starting to ease restrictions, it is imperative that transport authorities do this carefully and in a considered way in order to keep people safe from infection. In September 2020, Arup interviewed representatives from cities across the globe to understand the pandemic's impacts on transportation. This followed our May 2020 survey of our colleagues in East Asia focused on the pandemic's impact on public transit.

Our interviews focused on:

– understanding industry changes and potential policy approaches during the COVID recovery phase and as new, post-COVID travel patterns are established

– identifying if different policies and approaches are better suited for certain areas or types of cities vs others

– reviewing the effectiveness of policies driving behavioural change

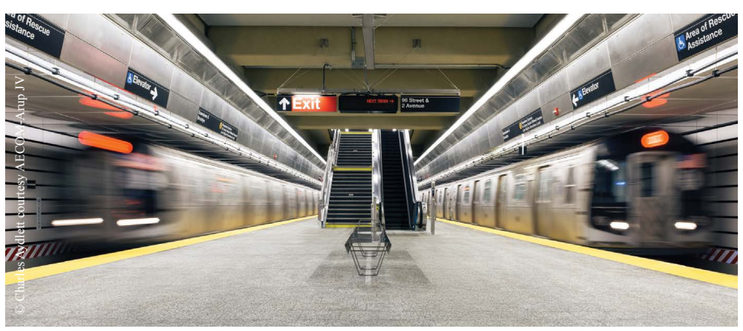
We have identified six key takeaways illustrated in eight different case studies.

Key takeaways

1

Regaining the public's confidence in transit is complicated and it often depends on local context.

- In Sydney: 'Safe capacity' standard established for transit operation
- In Chicago: Chicago Transit Authority (CTA) transit crowding data dashboard created during COVID to help customers better plan their transit trips to avoid heavy ridership periods
- In New York: Public perception of taking the subway vs the bus changed due to indoor health concerns



© Charles Mallett courtesy AECOM-Arup JV

Second Avenue Subway, part of the New York City Subway network.

2

Private vehicle ownership and vehicle miles travelled are on the rise despite continued remote working.

- In Sydney: Vehicle traffic returning to pre-pandemic levels despite most central business district (CBD) offices remaining empty
- In Istanbul: Car ownership is increasing while transit usage and other active modes remain low

In Istanbul, car ownership is increasing while transit usage and other active modes remain low.

In Sydney, vehicle traffic is returning to pre-pandemic levels despite most CBD offices remaining empty.

3

Temporary measures (e.g., slow streets, al fresco) transformed streets into liveable and desirable places.

- In Bogota: Expansion of bike lanes as cycling emerges as a socially distant way to travel
- In New York: Transformation of streets and parking spaces to ‘al fresco’ outdoor dining spaces made permanent
- In Paris: Development of ‘Corona cycleways’ and e-bike incentives continue to discourage Parisians from driving
- In San Francisco: Implementation of Slow Streets creates space for physical activity without impeding essential street functions

4

The pandemic further exacerbated pre-existing transport inequities.

- In Bogota: Land use patterns separating people from workplaces and social inequality result in high demand for public transit
- In Lima: Informal economy and reliance on public transit are key drivers for transit recovery for the region

5

Robust funding for transit operations is key for transit recovery and sustainability.

- In Paris: Investment in improving transit connectivity between suburban areas can be a learning model for cities
- In Chicago: US Federal funding for public transit operating expenses is crucial for the survival of transit agencies

6

The pandemic is a catalyst for more communication between regulatory agencies.

- In San Francisco: Blue Ribbon Transit Recovery Task Force paving the way for interagency collaboration in the Bay Area
- In Lima: Interagency and private provider collaboration for essential services may streamline future transport co-ordination
- In Istanbul: Official government-subsidised remote working gives transport providers clarity on near- and long-term recovery options

The findings of this research are now being used to support clients at different stages of recovery and help them decide what to do next. This work provides our clients with data driven insights that can help them to predict and understand the impacts of transport planning policies. In the longer term, this piece of work could be extended to review the effectiveness of policies to drive behavioural change.

View the full report online

Engagement and participation for knowledge sharing

Engagement activities encourage employees to connect, share and learn through the knowledge management (KM) portal and tools provided

The shift to remote or hybrid work arrangements as a result of the pandemic has prompted more organisations to find better ways for employees to share knowledge and learn proactively without boundaries. But relying on an intranet and online communication tools alone is not enough. A systematic KM strategy is needed to enable and motivate employees in the exchange of knowledge.

Drawing on our experiences in managing technical and project management experiences, we have been supporting government agencies, companies and industry bodies, especially those in the building and construction sector, to assess and improve the way they manage critical knowledge and related processes, infrastructure and management systems.

Specifically, we offer the following KM advisory services to clients:

– Develop KM roadmaps and strategies

– Create new and/or improve existing KM programmes

– Review project/business structures for sharing of best practices and lessons learnt

– Develop taxonomies to classify and organise documents and/or activities

– Design effective KM portals, repositories and toolkits

– Perform ongoing reviews and assessments

Arup University delivers a mix of training, coaching and workshops internally and to clients to foster a sharing and learning culture.

For example, for two government agencies we advised on as KM consultant, we helped them develop an organisational taxonomy, in which essential information is organised into a coherent structure and broken down into logical categories so that users can find the information or subject matter experts that they require more intuitively and easily.

Based on the taxonomy, we further helped them revamp their KM portals to make the contribution, sharing and discussion of knowledge more effective across the organisation. Having said that, the effectiveness of KM portal, among other things, lies in employee participation in the portal.

Ensuring an organisational culture of sharing and learning is first and foremost and it requires the commitment of the management not only to act as a role model but also for ensuring that employees can and do share and learn. That’s why we deliver a mix of training, coaching and workshops internally and to our clients to foster a sharing and learning culture.

One of the KM planning tools we have developed is a KM toolkit – a unique card-based system comprising three card sets providing comprehensive, intuitive guidelines for KM system development and implementation.

In the past few months, Arup University has organised participatory workshops for colleagues and clients alike to help them develop KM skills, strategy and framework.

Through train learning

The MTR Academy-Arup University CPD series combines theoretical knowledge and hands-on technical skills with the latest thinking in sustainable and low-carbon railway transport design and engineering.

With a growing demand for skilled professionals in railway planning, design and construction, the MTR Academy and Arup University joined together to offer a continuing professional training (CPD) series in September and October at the MTR Academy building in Hunghom, Hong Kong.

The goal of this training is to provide participants with a broader understanding of the entire rail station planning and development process, from transit-oriented development (TOD) planning to ensuring the comfort, safety and seamless journey of every passenger.

The CPD series began with fundamental station design principles, strategies and real-world examples and ended with the future of rail and smart cities that are currently being envisioned. Taught by experts from Arup and the MTR Academy, the CPD series includes seven lectures covering fire engineering, station and tunnel environmental control, station planning and design, crowd management using simulation, TOD planning and design, emerging trends in smart cities, and the future of railway stations.

The lectures were attended by practitioners of the MTRC, government agencies, engineering firms, shipping companies and university students, as well as practitioners and students joining the event from overseas online.

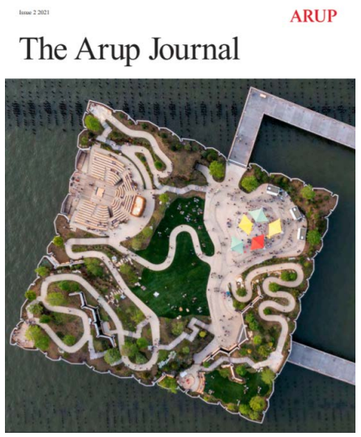
By organising training programmes in collaboration with other professional bodies and institutes, Arup University is committed to empowering industry practitioners and colleagues with the skills in design, engineering and project management they need to help shape a better world.

Arup speakers	Lecture topics
Dr Young Wong Anny Ip	**Application of fire engineering in the design of railway stations and tunnels** Fire engineering principles, fire science and technical tools deployed in fire engineering; fire safety issues and challenges of different types of railway station and tunnel design; components of fire safety strategy; acceptance criteria and quantitative assessment at the design stage.
Gordon Choi	**Introduction to station/tunnel environmental control system (ECS)** Air-conditioning principles, loading estimation and specific applications; station smoke control principles, design criteria and system arrangement; station mechanical ventilation principles and system arrangement; recent development in ECS application for railway station; tunnel ventilation design principles, parameters, standards and modes of operation.
Karma Barfungpa	**Station planning and design** Station planning principles; life safety and operational requirements; design standards and norms in station design; station typologies and international variations (a look at deep, shallow and above-ground station design and its characteristics); transport-oriented development (TOD) and stations.
Clement Ho	**Crowd management using simulation analysis** Benefits and limitations of crowd simulation and analysis; key crowd simulation modelling elements for station design; crowd control and simulation modelling for station vs retail environment; using crowd simulation model to measure design performance; advanced technology to improve model results; use of virtual reality (VR) and advertising space.
Sam Chow	**TOD in the context of sustainable urbanism** Background and types of TOD in various city contexts; applications of TOD in Hong Kong and other Chinese cities; ways that TOD could help to achieve sustainability goals; roles of TOD amid shift to smart mobility; integration of TOD with new transport elements, such as mobility as a service (MaaS) and connected and autonomous vehicles (CAV).
Carmen Chu	**Emerging trends in smart cities: intelligent mobility system** Latest intelligent mobility (IM) technologies and applications; policies supporting IM deployment in HK; use cases, i.e. automated parking, connected/ autonomous vehicles, intelligent traffic signal and free -flow tolling system; IM provision in railway station design; MaaS and its applications

Karma Barfungpa, Director of Architecture, Building Envelope & Materials at Arup in East Asia, gives a talk on railway station planning and design guidelines and case studies.

Sam Chow, Leader of Transport Consulting at Arup in East Asia and an Arup Fellow, talks on the evolution of transit-oriented development (TOD) in East Asia and explores the future of mobility.

Dr Young Wong, Director of Fire Engineering at Arup in East Asia, presents a lecture about fire engineering in the design of railway stations and tunnels.



Latest Arup Journal available

For over 50 years, Arup has published journals, research reports, whitepapers and other content that demonstrate the firm's technical excellence. This has made Arup the go-to partner for project owners looking to execute a planning, development or engineering project. Flashback to 1966, the inaugural issue of The Arup Journal features a tribute to Ove Arup entitled 'Obverse and reverse'. The latest issue includes a range of diverse projects highlighting our positive impact on the built environment.

Read the latest Arup Journal

Arup's Tall Buildings in Asia: Chinese edition available

The Chinese edition of Arup's Tall Buildings in Asia (《奥雅纳亚洲超高层建筑集萃》) has recently been published. Based on the English edition, the Chinese edition provides valuable updates on some topical issues such as the application of digital tools in tall building design, operation and maintenance with some more recent case studies. The collation of this book was led by Arup University in collaboration with Arup Fellow, Dr Goman Ho, and the Marketing and Communications team. More than 50 experts in the East Asia offices have contributed to the success of this book.

Purchase online

Read the full article

Future mobility hubs

As the transport sector strives to decarbonise, it is essential to rethink how we integrate public transport services with walking, cycling, and micro-mobility to make it easier for people to travel seamlessly. Mobility hubs are places where people can switch from one mode of transport to another, with convenient facilities designed for a low-carbon society. They form a network of structures that cluster together a full suite of complementary transport modes to enable sustainable journeys. The purpose of this document is to share Arup and Go-Ahead's vision for how Future Mobility Hubs can be developed for different contexts across the UK. Through illustrations, we outline key design principles that explore scalability, adaptability and potential uses.

Acknowledgements

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