



December 2020

CHINA REPORT

CONSTRUCTION PROCUREMENT AND
COST INTELLIGENCE

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Christchurch

Hamilton

Palmerston North

Queenstown

Tauranga

Wellington

OUR NEW MISSION IN PROJECT COST REFORMS IN CHINA

The General Office of the Ministry of Housing and Urban-Rural Development issued the 'Work Plan on Project Cost Reforms' on 24th July 2020 in order to let the market play the decisive role in allocating resources and help the construction industry reform. The work plan, guided by Xi Jinping's thought of socialism with Chinese characteristics in the new era, pursues the government's mission to promote high-quality development of the construction industry. While stressing the decisive role of the market, it is also important to know both market and government playing key roles in an intertwined way. The work plan incorporates a number of measures to improve the mechanism of market-based project costs. Such measures include standardising the measurement and pricing rules, encouraging competitive tendering and systematic sharing of construction project data, as well as strengthening cost control and contract management.

Most current China's state-owned projects have not yet adopted the market mechanism thoroughly. In addition, there are several deficiencies in the existing cost management system such as the fragmented cost management, the use of fixed rates for budget establishment, setting tender price ceiling, passive cost management, insufficient level of details for the preparation of Bills of Quantities, and ineffective contract management. Inaccurate project estimates, a lack of competitive bid and budget overrun.

Since entering the China market in 1979. Our quantity surveying services are widely recognised by our prestigious clients ranging from wholly foreign-owned enterprises, sino-foreign equity joint ventures and private enterprises to state-owned enterprises. The newly announced reform programme aligns with our core objectives to drive the construction market to achieve the standards of marketization, internationalization, legalization and informatization.

Our key quantity surveying services include: 1. Preparing a realistic market-based budget estimate ; 2. Working with the client and design team to develop quota design and construction standard specification; 3. Drafting contract clauses to suit the special circumstances of each project; 4. Obtaining competitive prices from selected contractors by tendering with Bills of Quantities and conduct in-depth tender evaluation to reduce contractual risks; 5. Providing full cost control and monitoring services; 6. Providing research services including establishment of construction cost database, publication of cost indicators, cost information of labour, materials and equipment, etc.; 7. Providing employee training.

RLB is always fully confident in the project cost reforms in China. With a dedication to promoting the application of international cost control model, our mission is to contribute to the reforms with our accumulated knowledge and expertise in cost management.

LEED SCORE POINTS AND COST ANALYSIS

LEED certification has been adopted in China since 2003 with first registration in 2004. The number of LEED-registered or certified projects has increased gradually. LEED certification is common in high-end commercial projects. In China, the establishment of the "Green Building Evaluation Standard" is based on LEED. It is mandatory for projects with building area of more than 20,000 square meters to obtain the two-star green building. This article will identify and study the cost drivers for upgrading a two-star green building to LEED Gold and Platinum.

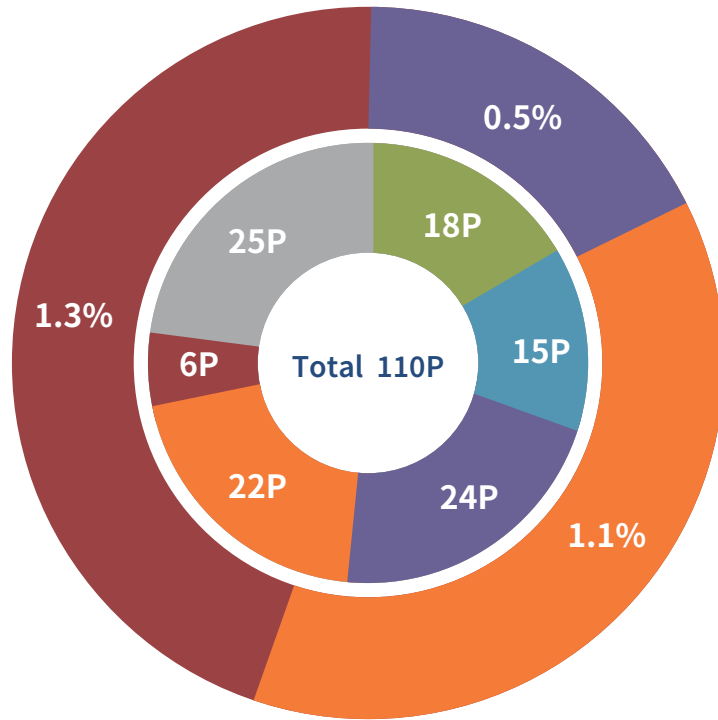


(For illustration only)

- The selected project is located in Shanghai, with total construction area of approximately 180,000 m². It is a high-end commercial-office building. The main business types are shopping malls, offices and hotels.
- Prior to the LEED evaluation, this project has achieved the requirements of the two-star green building.
- The case study will analyze the additional costs based on the requirements of LEED. LEED score points (LEED V4 version) are based on analytical reports provided by the LEED Consultants.

LEED SCORE POINTS AND COST ANALYSIS

- 01 Mandatory
- 02 Scored Items
- 03 Easy-To-Achieve
- 04 Moderate difficulty
- 05 Difficult-To-Achieve
- 06 Higher Difficult-To-Achieve
- 07 Impossible-To-Achieve



LEED Gold Award: 60 points LEED Platinum Award: 80 points
 Percentage: the percentage of incremental cost in the total cost

- Mandatory**
 Not scored but must be met, cost involved has been included in the SD estimate
- Scored Items**
 18 points in total, cost involved has been included in the SD estimate
- Easy-To-Achieve**
 15 points in total, cost involved has been included in the SD estimate
- Moderate difficulty**
 24 points in total, involving small increase in cost
- Difficult-To-Achieve**
 22 points in total, involving large increase in cost
- Higher Difficult-To-Achieve**
 6 points in total, involving large increase in cost
- Impossible-To-Achieve**
 25 points in total, no cost is considered

LEED SCORE POINTS AND COST ANALYSIS

Discipline	Score Item	Design Requirements	Score	% increase in cost		Notes
				Gold	Platinum	
Mandatory Items						
Architecture	Recyclable Material Collection	Provide garbage room with good accessibility for collecting and storing the recyclable garbage of the building, with the area not less than 50 square meters	P	-	-	No cost implication compared with scheme w/o LEED
	Environmental Smoke Control (Landscape Related)	The outdoor smoking area should be more than 8 meters away from the entrance, fresh air inlet and activity window	P	-	-	
		Place a sign within 3 meters of all building entrances to mark the smoke-free policy		-	-	
	Energy Saving	Doorways or revolving doors are arranged at the entrances and exits of the building (ASHRAE 90.1 mandatory rules)	P	-	-	
Landscape	Water Saving for Exterior Irrigation	Use local plants to reduce the proportion of turf	P	-	-	
		Use drip irrigation or other water-saving irrigation systems		-	-	
HVAC System	Minimum Fresh Air Volume	According to ASHRAE 62.1 - 2010, the minimum fresh air volume of mechanical ventilation system was determined	P	-	-	
		Fresh air volume monitoring (set flow meter and constant air volume valve)		-	-	
	Energy Consumption Meter	Provide a meter for measuring hot and cold water of air conditioning	P	-	-	
	Water Saving Cooling Tower (Water Supply and Drainage)	For the cooling tower and the evaporative condenser, the water meter, the conductance controller and the overflow alarm should be equipped. The floating water rate in the countercurrent cooling tower should be at most 0.002% of the recycled water volume, and the floating water rate in the cross-flow cooling tower should be at most 0.005% of the recycled water volume	P	-	-	
	Refrigerant Management	Do not use refrigerants containing CFCS, use environmental refrigerants. Do not use fire extinguishing systems containing CFCS, halogen extinguishing agents or other ozone-depleting substances.	P	-	-	
PD System	Indoor Water Saving	Use water-saving appliances	P	-	-	
	Water Meter	Install a permanent water meter to measure the amount of water usage in the project (both the building and the site)	P	-	-	
EL System	Usage Meter	Provide master meter for electricity usage	P	-	-	
Lighting System	Lighting Design	1. Multistage lighting control 2. Duty sensor 3. Automatic daylight control 4. Separate, multistage control of outdoor lighting 5. The lighting power density of building facade should not be larger than 1.6w /m ²	P	-	-	
Construction /Materials	Sustainable Construction	Formulate and implement soil erosion and sediment control plan (basically equivalent to the civilized construction requirements of Shanghai)	P	-	-	
	Waste Management	Develop construction waste management plan	P	-	-	
	Commissioning	Appointment of commissioning specialist	P	-	-	
Record and summary		P	-	-		
	Total of the Mandatory Items		P	-	-	
Scored Items						
Site Selection	Land Status	Site on previously developed land	2	-	-	No cost implication compared with scheme w/o LEED
	Peripheral	1. High degree of peripheral development 2. Complete supporting facilities	6	-	-	
	Public Transport	Public transport connections, double the capacity of buses required by LEED	8	-	-	
Others	Design Management	In the early stage of the design, integrate every disciplines	1	-	-	
	LEED AP	The project team has LEED AP members	1	-	-	
	Total of the Scored Items		18	-	-	
Easy-To-Achieve						
Architecture	Motor vehicles Lots	Not exceeding local regulations of parking spaces	2	-	-	No cost implication compared with scheme w/o LEED
		5% car sharing preferred parking space, 5% green energy preferred parking space, located near the elevator hall and on the ground floor		-	-	No additional costs if use the wall or ground marking; For reserved parking additional cost = 120no. *1500 RMB/ no. = RMB18M
		2% charging piles		-	-	
Landscape	Water Saving for Exterior Irrigation	Use rainwater/reclaimed water as a source of irrigation	2	-	-	No cost implication compared with scheme w/o LEED
	Open Space	Provide outdoor space up to at least 30% of the total site area. At least 25% of the outdoor space must be covered with vegetation (turf is not vegetation) or covered with a plant canopy	1	-	-	
HVAC System	Refrigerant Management	The refrigerants of low ozone sphere destruction and low HGWP	1	-	-	
PD System	Water Metering	Itemize the system of domestic water, domestic hot water, reclaimed rain /reclaimed water, irrigation, boiler refill and cooling tower refill	1	-	-	
	Water-saving Appliances	First class water-saving appliance and meet the flow requirements	2	-	-	
	Water Quality Analysis	Perform cooling water quality analysis and measure the following parameters: Ca concentration, total alkalinity, SiO ₂ concentration, Cl-concentration, conductivity	1	-	-	Minimal cost implication
Others	Environmental Assessment	Conduct environmental assessment of LEED requirements based on EIA report, geological survey report, sunshine analysis, etc.	1	-	-	Included in the LEED consultancy Fee
	Tenant Convention	Develop tenant design and construction requirements, related to tenant delivery standards, and restrict tenant secondary decoration design	1	-	-	Included in the LEED consultancy Fee
Construction /Materials	Waste Management	Develop a building construction waste management plan that identifies at least 5 materials (building and non-building materials) to be converted, and that recycles or reuses at least 75% of the waste from the demolition and construction of the building	2	-	-	No special materials required
	Indoor Construction Management	Control indoor air quality during construction	1	-	-	construction requirements, the cost has been considered in the scheme design estimate
	Total of the Easy-To-Achieve		15	-	-	

LEED SCORE POINTS AND COST ANALYSIS

Discipline	Score Item	Design Requirements	Score	% increase in cost		Notes
				Gold	Platinum	
Moderate difficulty						
Architecture	Bicycle Facilities	204 long-term bicycle slots; 204 short-term bicycle slots	1	-	-	No cost implication compared with scheme w/o LEED
		Bicycle storage must be within a walking distance of 60 meters from the main entrance		-	-	
		20 public shower and dressing rooms		-	-	
	Indoor Air Quality	A permanent mat system shall be used at the all main entrances and exits (temporary mat may be used for underground area) to a depth of at least 3m and shall be indoor	1	-	-	
	To the space (such as garage, cleaning room, laundry area) that may have dangerous gas or chemical substance, set self-closing door and top to top partition	-		-		
Good View	75% of the building area of all commonly used Spaces must have two or more excellent views (1. multiple lines of sight; 2. Visual field characteristics; 3. The visual field within three times the height of the viewing window is unimpeded; 4. Visual field coefficient). And the view facing the atrium occupies at most 30% of the standard area.	1	-	-		
Landscape	Reduce the heat island effect	Planting roof	2	-	-	No cost implication compared with scheme w/o LEED
		High reflective roofing (initial SRI value at least 82, generally light colored)		-	-	
		High reflective ground paving (initial SR value at least 0.33, generally light color)		-	-	
	Sponge City Design	The concave green space, rainwater garden and ecological ditch are set to solve part of the rainwater runoff	4	0.06%	0.06%	Increase 100 yuan /m ²
	Set up rain pool to solve other rainwater runoff	0.07%		0.07%	To be designed to give a clear plan, temporarily add 500 cubic PP storage module (without water treatment)	
HVAC System	Indoor Air Quality	Adequate exhaust (at least 2.54L/s per square meter) of space where hazardous gases or chemicals may be present, e.g. garage, cleaning room, laundry area.	2	-	-	No cost implication compared with scheme w/o LEED
		Use a MERV13 (G4+F7) or higher filter		-	-	The scheme design estimate includes MERV13 (G4+F7) but does not include the higher filtering
		CO2 monitoring should be set for all the assembly occupancies (designer density >0.25 people /m ²). The installation position of CO2 monitor is 0.9 to 1.8m above the ground, and will trigger the alarm when CO2 concentration exceeds 10% of the set point		0.01%	0.01%	Based on 100 no. monitoring points assumed
	Air Pollution Emission	In the condition of 3% oxygen radicals, no more than 30ppm of nitrogen oxides and 400ppm of carbon monoxide will be emitted from the exhaust of boiler combustion	1	-	-	The boiler manufacturer confirm no additional cost
		No more than 11ppm of nitrogen oxides, no more than 30ppm of VOC and no more than 70ppm of carbon monoxide should be emitted from diesel generator		-	-	Mainstream generators basically meet the requirements, no additional costs
	Advanced Energy Metering	Metering the energy consumption of cold and hot water in the air conditioning according to the tenant area, at least one meter for each energy type in each floor (considering one energy meter for each riser in each floor)	1	-	-	No cost implication compared with scheme w/o LEED
	Energy Saving Strategy	Frequency conversion of primary pump	4	-	-	No cost implication compared with scheme w/o LEED
		Fan unit power optimization		-	-	For air conditioning fans, the additional costs is minimal
		Frequency conversion of PAU		-	-	No cost implication compared with scheme w/o LEED
		Exhaust heat recovery		0.10%	0.10%	PAUs of all areas (except basement) add heat recovery
Variable speed of cooling tower fan		-		-	No cost implication compared with scheme w/o LEED	
	100% fresh air during the transition season (lobby and commercial public areas)		0.02%	0.02%	Assume 100% fresh air volume of AHU at the lobby and commercial area	
EL System	Energy Demand Response	Develop an energy demand response plan to reduce the building's expected peak electrical load by at least 10%	1	-	-	Basically no extra work
		The BA system requires remote control of hvac, lighting and other energy systems to implement the energy demand response plan		0.10%	0.10%	Add lighting control system
		Using remote meter, electric meter need points automatically record information and provide energy consumption and demand		0.05%	0.05%	Add remote meters to the energy metering system
	Advanced Energy Metering	The total electricity is measured by tenant area	0	-	-	No cost implication compared with scheme w/o LEED
Energy Saving Strategy	The lighting power density reaches the target value	0	-	-	No cost implication compared with scheme w/o LEED	
Lighting System	Low Mercury Lamp	The average mercury content per lumen hour for all lamps within the project boundary (both indoor and outdoor) must not be higher than 70 picogram	1	-	-	No cost implication compared with scheme w/o LEED
Construction /Materials	Testing	Enhanced debugging plan, training, system maintenance manual	3	-	-	Additional consultancy fee for commissioning, limited impact on the construction cost
	Low Volatile Material	Coatings, paints, sealants, binders meet VOC control indicators	1	-	-	No cost implication compared with scheme w/o LEED
	Construction Material	Using responsibly mined raw materials, material characteristics may include recycled ingredients, local materials, FSC wood, bio-based materials, or products that meet the expanded producer liability standard	1	0.10%	0.10%	Additional cost RMB10/m ² (CFA)
Total of the Moderate difficulty			24	0.5%	0.5%	

LEED SCORE POINTS AND COST ANALYSIS

Discipline	Score Item	Design Requirements	Score	% increase in cost		Notes
				Gold	Platinum	
Difficult-To-Achieve						
Landscape	Edible Landscape	5% of the green area is set as experiential farmland, and the total area should not less than 250 m ²	1	-	-	No cost implication compared with scheme w/o LEED
		15% of the roof can be green area (remove equipment placement area, skylight, emergency access, drainage ditch, etc.) set as experience farmland				
HVAC System	Energy Saving Strategy	Optimize the COP of the chiller by 6%	4	-	0.08%	The additional cost based on 10% of the cold source (excluding the Air-cooled heat pump)
		The boiler efficiency reach 94%		-	0.03%	Add energy saving device, cost based on 10% of the heat source (excluding the Air-cooled heat pump)
EL System	Energy Saving Strategy	The power density of office lighting shall be no more than 8W/m ²		-	-	Choose Philips or OPPL brand LED lights, costs are included in the scheme design estimate
PD System	Flushing with Rainwater /Reclaimed Water	Adopt rainwater/reclaimed water flushing system to achieve water saving rate of 55%	5	-	0.06%	Rainwater reuse has been considered in the scheme design estimate, adding the reclaimed water system
	Cooling Water Treatment	Add cooling water treatment facilities, improve the quality level of cooling water or supplementary water treatment, and increase the number of cooling water circulation	1	-	0.18%	Assume the maximum capacity of 50m ³ /h, based on LEED consultant's advise
Lighting System	Outdoor Light Pollution	For the site lamps, should choose products with low irradiation angle, and control the light with high irradiation angle and upward irradiation, so that the BUG rating of each lamp meets the requirements of LEED on light pollution	1	-	-	Control system of landscape lighting design, no cost impact is considered for now
Construction /Materials	Commissioning	Arrange the commissioning of the peripheral protection structure, including the air tightness test	4	-	0.06%	Increase 10 groups of the curtain wall performance commissioning (0.1M /group), and increase the sky-curtain type commissioning fee of 0.2M
		Commissioning based on monitoring protocol		-	-	Included in BA commissioning, no extra cost
	LCA Analysis of Materials	LCA analysis of the whole building is conducted to prove six indicators of the building such as global warming potential value	1	-	-	Increase the cost of LCA analysis, no implication on the construction cost
Construction /Materials	Procure Certified Building Materials	Certified EPD products with at least 20 permanent installations from at least 5 different manufacturers	1	-	0.59%	There are related certified products in the domestic certification system, and the LEED consultant needs to suggest common brands for estimate use. Assumed RMB100/m ² additional cost (above-ground GFA) (most products choose domestic certified products).
		In addition to the above requirements, these manufacturers should require published CSR reports from their raw material suppliers	1	-		
		Manufacturers should issue the lists of chemicals for their products, including "health product claims", "cradle to cradle", "manufacturer lists program", or other relevant programs	1	-		
Others	Procurement of Green Electricity	Procurement of Green Electricity	2	-	0.08%	Assume 1.5M maximum
		Total of the Difficult-To-Achieve (Only 3 points are required for gold award)	22	-	1.1%	
Higher Difficult-To-Achieve						
EL System	Renewable Energy	Using renewable energy systems to reduce the building's energy cost by 1%, e.g. expected to install 1,400 m ² of solar PV panel	1	-	0.36%	Add 1,400 m ² solar PV panel
Construction /Materials	Low Volatile Material	Flooring, composite wood, ceiling, walls, insulation and sound insulation materials, furniture should meet VOC control indicators	2	-	0.12%	Assume RMB20/m ² additional cost by above-ground GFA (mainly to increase the cost of material testing fee)
HVAC System	Energy Saving Strategy	Optimize the COP of the chiller by 12%	3	-	0.14%	15% extra cost add on the basis of COP optimization of chiller by 6%
		Add frequency function		-	0.07%	Additional 15% cost
		Volume up fresh air for office areas gain during the transition season		-	0.14%	Consider 50% increase in fresh air volume for AHU in office
		Cold radiant ceiling		-	0.45%	Additional cost based on the VAV system of the office
		Solar photovoltaic power reach 1%		-	-	Consider that the above EL points have met the requirements
		Total of the Higher Difficult-To-Achieve (Not required for gold award)	6	-	1.3%	
Impossible-To-Achieve						
Others	High Priority – Site Selection	Historic district, national/provincial priority development area, or brownfield	3	-	-	The site of the project does not meet the design requirements
	Conservation and Restoration of Habitats	1. Local native vegetation restoration of 30% of site 2. Deal with disturbed soil	2	-	-	1. Insufficient greening 2. Soil treatment is difficult to achieve
	Energy Demand Response	Connect to local demand response plans	1	-	-	There is no local demand response plans
	Reduce Lifecycle Impact	1. Reuse of historic buildings 2. Reuse of old buildings	3	-	-	Not applicable
	Publicity and Optimization of Construction Product Analysis	For products with a total project cost of 25%, should meet the requirements for EPD certification, responsible production plan, and material composition certification	3	-	-	LEED requires internationally certified products, which cannot be achieved in domestic projects
	Renewable Energy Production	Use renewable energy systems to reduce at least 3% of the building energy	2	-	-	Based on project development density and renewable resources, 3% offsets cannot be achieved
	Natural Lighting	Achieve sDA300/50% natural lighting for 55-90% of the space each year, and less than 10% ASE1000,250 of the sunlight irradiation	3	-	-	The capacity of natural lighting is limited for the area facing the atrium according to the current architectural design
	Energy Efficiency Optimization	Compared with ASHRAE 90.1-2010, energy cost savings reached 3%-47%, with a total of 18 points, including 8 points of impossible items	8	-	-	Development density and business type are limited, and the energy saving rate cannot reach the top score
		Total of the Impossible-To-Achieve	25	-	-	
		Total Score and Increased Cost	110	0.5%	2.9%	

LEED SCORE POINTS AND COST ANALYSIS

In summary, the case specifically analyzes the cost increment corresponding to 85 points out of all points, and the preliminary conclusions are:

- Reach 60 points to get a Gold Award: On the basis of fulfilling all mandatory items, scored items, easy-to-achieve, and moderate difficulty, 3 more points should be obtained from the difficult-to-achieve. To meet such requirements, the additional construction cost required based on the Green Construction Two-Star Program is about 0.5% of the total construction cost.
- Reach 80 points to get a Platinum Award: Considering a safety threshold of 2 ~ 3 points, a trade-off has to be made among the difficult-to-achieve according to the characteristics of the project. To satisfy all necessary requirements, the additional construction cost required based on the Green Construction Two-Star Program is about 2.9% of the total construction cost.



(For illustration only)

Based on these conclusions, apparently the additional cost required to achieve the LEED Platinum Award is much higher than that of winning the LEED Gold Award. In comparison, the LEED Gold Award is more cost-effective. This phenomenon is also reflected in the market share. The projects that have won the gold award in the domestic market account for 60% of all LEED projects, while the corresponding share of projects achieving the LEED platinum award is only about 10%. The developers need to make judgement on whether it is necessary for the project to receive the LEED Platinum Award based on the project's leasing market research.

SMART BUILDINGS

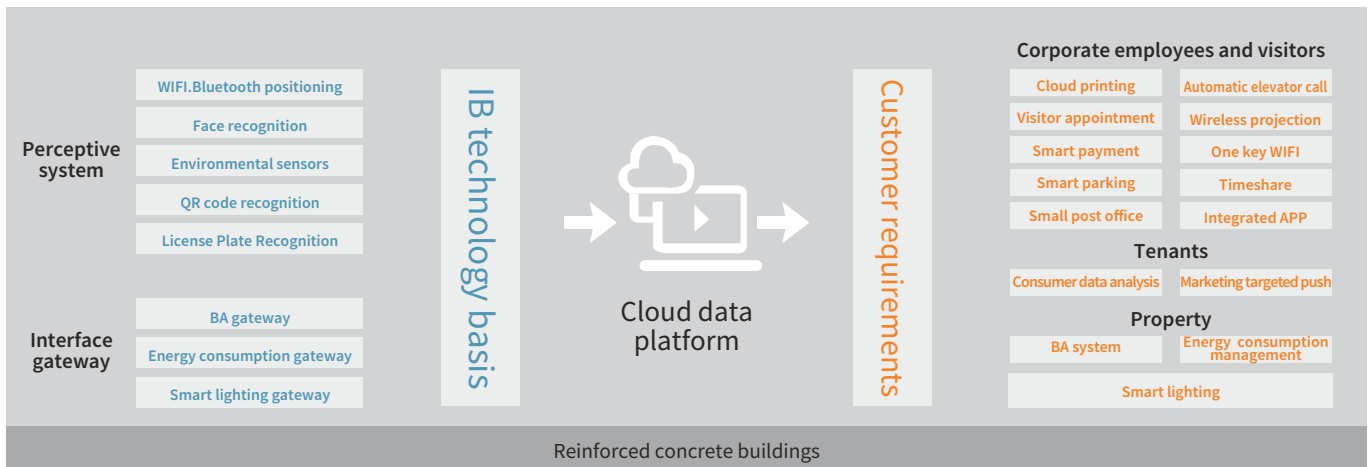


In recent years, with the widespread use of high-tech intelligent control systems in the field of office buildings, building control, fire protection, and security have become increasingly intelligent and have become independent control subsystems. With the changes in the main body of economic development, there is a rise in the number of new developers in the construction industry, such as e-commerce. The participation of these emerging developers has greatly promoted the development of Internet cloud technology and intelligent control systems, bringing a new term—"smart building".

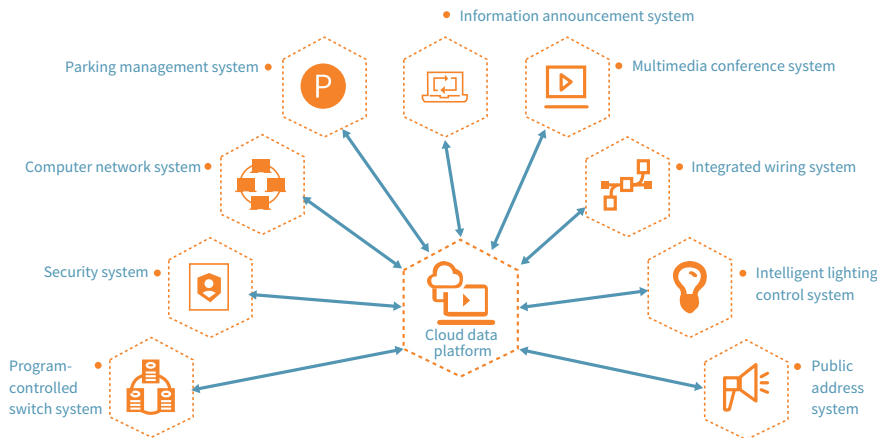
There are 5As regarding the concept of building intelligence: OA (Office Automation), BA (Building Automation), CA (Communication Automation), FA (Fire Automation), and SA (Security Automation). Smart buildings, the product of further development of building intelligence, is the result of integration of mobile communication devices, perception devices in buildings, Internet cloud data analysis, intelligent control systems and the main body of the building. With the full use of Internet cloud technology and intelligent control systems—taking a smart office building newly built by an e-commerce company in Guangzhou as an example—the cost/m² of the ELV system has approximately doubled.

The realization of smart buildings at this stage is mainly to increase the installation and use of sensing equipment to collect behavior data, traffic data, equipment operation data, etc. in the building, and to connect and control the collected data through standardized ports and network protocols, forming a fundamental data cloud platform for the building. The core of smart building is the "cloud data platform". This platform is not only a bridge linking customer needs and the technical basis of intelligent building (IB), but also a transportation hub connecting various systems within the building. In the past, various systems in office buildings were mostly closed systems. Each system was independent of each other and could not work with one another. Now that the foundation of IB technology connects all systems to the Internet, so the fundamental data collected by each system will be processed and analyzed through the cloud data platform, then the setting of different building systems will be adjusted to suit different customers' need. In this way, all systems are linked and controlled. At the same time, data can be shared between deferent regions to support big data analysis. Using the cloud data platform as a basis, application scenarios are developed and generated as output to provide customers with energy-saving and time-saving high-quality building space experience. It also provides customers with an open, free, collaborative, and shared smart office experience.

SMART BUILDINGS



For example, when a customer registers visitor information in a corresponding software, the parking lot system will reserve parking spaces according to the registered license plate number, and guide the customer to park through the vacant parking space guidance system. When the customer leaves, the parking fee will be automatically deducted from the authorized payment methods without requiring the driver to pull over. When the customer passes through the passage gate, the face recognition system will automatically open the gate according to the registration information, allow entry and arrange a elevator to pick him up to the corresponding floor. Customers may rent offices or meeting rooms at different time slots through QR codes in their mobile phones. The interconnected indoor lighting, air conditioning, and multimedia conference systems will be turned on and ready to be used immediately. When the indoor all-in-one sensor detects an increase in concentration of carbon dioxide, i.e., when the number of people in the room increases, it will automatically adjust the air-conditioning circulation system to increase the air volume, and turn on the air purifier and other equipment in parallel. If printing and other office services are required, the customer may register, collect and have their payment settled through QR codes in their mobile phones.



The future of smart buildings (excerpted from "Ali Smart Building White Paper"):

- Environmental dimension**-environmentally friendly, resource optimization, green and energy saving.
- Economic dimension** - covers the entire construction and operation life cycle. Low operating costs, relatively high construction costs, high return on investment, low life cycle costs.
- Social dimension** - more comfortable HVAC and lighting experience, more efficient environment, healthier living environment, more user-friendly equipment, better security, higher space utilization and flexibility.
- Technical dimension**-sensor network and control system, new product materials, innovative design, integrated management, technology penetration.

Regarding smart buildings, Professor Zhang Ruiwu of Tsinghua University gives a relatively complete definition: smart building is a combination of intelligent computer technology, communication technology, control technology, multimedia technology and modern architectural art. It is also an optimized combination of users' information services and the building environment through the automatic monitoring and management system to suit the needs of modern buildings including the characteristics of safety, efficiency, comfort, convenience and flexibility.

With the continuous development of technology, smart buildings will provide a safer, more efficient and healthier environment for all. Smart buildings will become a major part in the process of building smart cities, and the integration of smart buildings and smart cities will surely become an inevitable trend in urban development.

AVERAGE WHOLESALE PRICES OF SELECTED BUILDING MATERIALS IN SELECTED CITIES OF CHINA (RMB)

(3rd Quarter 2020 Prices)

Building materials		Beijing	Chengdu	Chongqing	Guangzhou	Hangzhou	Nanjing	Shanghai	Shenyang	Shenzhen	Tianjin	Wuhan	Xian	
1	Reinforcement bar HPB235 (1st-class) 10mm	¥/t	4,106	3,461 HPB300 8-10mm	3,953 HPB300	3,963 HPB300	4,090 HPB300	4,514 HPB300	4,133 HPB300	3,393 HPB300	4,418 HPB300 (1st class) 6.5-10mm	4,362 HPB300	4,009 HPB300	3,973 HPB300
2	Reinforcement bar HRB400 (3rd class) 10mm	¥/t	4,080	3,511 HRB400 8-10mm	3,987	3,971	4,108	4,317	4,130	3,520	4,535	4,043	4,148	3,930
3	Reinforcement bar HRB400 (3rd class) 25mm	¥/t	3,690	3,471 HRB400E	3,927	3,980	3,996	4,235	3,970	3,407	4,251	4,022	3,893	3,930
4	Reinforced concrete Grade C30 5-25mm aggregates P8 waterproofing (without pumping fee)	¥/m ³	508	520 5-31.5	437 Average of main areas of the city, electric pump	623	591	561	638	337	656	533	504	626
5	Timber Formwork local commonly used materials	¥/m ³	2,000	3,004 1830×915×15	1,115 Average of main areas of the city, logs	1,348 pine broad	1,780 pine logs Φ14-16 x 600cm	1,797	1,851	1,883	2,522 1830×915×18 3rd Class blackboard	2,037 logs	2,203	2,061 pine logs
6	Portland cement Grade 42.5(bulk)	¥/t	455	412	483 Average of main areas of the city, bagged	502	518	477	507	330	549	448	444	503
7	Sand Rough/mixed	¥/t	102	129	258 Average of main areas of the city, extra fine sand	184	130 Gross sand	191	170	55	131	90	252	247
8	Hot rolled steel angles 45-50×3-6mm	¥/t	3,799	3,584 Q235 L50×50×5	4,157 Q235 4-8mm	3,968	4,253 Q235B	4,405 Equal-leg angle steel	4,027 Equal-leg angle steel 45-50 × 3-5mm	3,403	4,610 Angle steel	4,113	4,092 Equal-leg angle steel 45-50 × 3-5mm	4,247
9	Galvanized steel sheet 1.0mm	¥/t	4,646	5,733 0.5-1.2mm	4,930	4,327	4,818	5,229 Hot galvanized steel sheet Q235B	4,600 Hot rolled steel sheet Q235 δ≥1.0	4,100 Continuously hot-dip zinc-coated steel sheet 1.00-2.5 Z275(two-sided)	5,191	4,888	4,877 Hot rolled steel sheet Q235 δ≥1.0	5,007
10	Seamless steel pipe 108×3.5-4mm	¥/t	4,383	5,700	4,853 108 x 4.5mm	4,935	5,610 108x4mm	5,040	5,589 108×3-4.5mm #20	4,057 68-159	5,427 Seamless steel pipe	4,730	4,488 108 × 4.5-5mm	4,707
11	Galvanized welded steel pipe 20mm 26.75×2.75mm	¥/t	5,631	5,396	5,530 Hot dip galvanized steel pipe Q235 / Q195 DN15-20	5,620 Galvanized water, gas transportation pipe	5,714 20*2.8mm	5,718 Hot dip galvanized steel pipe DN15~DN32	5,110 Φ20 mm	3,747 DN25~DN32	5,920 Hot-galvanized steel pipe	5,553	5,634 20×2.75mm	4,993
12	Hot-rolled steel channel Grade a steel #16-18mm	¥/t	3,777	3,673 Q235 #18mm	4,193 Q235 16-22#	4,003	4,222 Q235B	4,263 Steel channel	3,873 Q235 16#	3,463 5-30#	4,537 Steel channel	3,914	4,157	4,233
13	Float glass 5mm	¥/m ²	23	24 White float glass	27 White float glass	33	37	39	27	29	33	30	33	39
14	Aluminium A00 aluminum ingot	¥/t	14,600											
15	Copper 1# electrolytic copper	¥/t	51,553											
16	Steel fire-rated door (Grade II)	¥/m ²	412(#)	550(#)	520	368 Single-leaf	520	615 Single-leaf	789	583	600(#)	590(#)	595(#)	637
17	Timber fire-rated door (Grade II)	¥/m ²	410(#)	380(#)	320	430 Single-leaf	430	-	490	481(#)	680(#)	470(#)	504(#)	485
18	PHC piles Φ 400A	¥/m	-	165(#)	-	139 Thickness 95mm	151 Thickness 95mm	204	167 Φ400AB Thickness 95mm	95(#)	142 Thickness 95mm	128 Φ400AB Thickness 95mm	195(#)	252
19	APP Modified Bitumen Water - proofing membrane 3mm PY	¥/m ²	32	38(#)	24 APP- I -PY-PE-3mm	27	36 4mm	35	27 APP-I-PY-PE	26(#)	34(#) SBS 3mm	34(#)	27	31
20	JS Cementitious Waterproofing Coatings Type I two-component	¥/kg	10	18(#)	15 JS-I latex	12	8	9	11 JS-I	10(#)	12	13	18(#)	19
21	Interior wall Latex paint Type II	¥/kg	17	15(#)	9 paint	11	17 latex paint	13	16(#)	11	11(#)	12	10	16(#)
22	Advanced Acrylic Exterior Wall Latex paint Type II	¥/kg	25	23(#)	28 import emulsion paint (luminant)	27	21 elastic emulsion paint	16	24(#)	12	25(#)	25	33(#)	24(#)

Notes:

- The above prices (except items 14, 15 and those marked with "#") are based on guiding price from websites; periodicals published by local construction cost management office; or market prices published by "China construction material online";
- Items 14 & 15 in the above table are based on final price by end of month published by Shanghai Futures Exchange (www.shfe.com.cn), as a general reference price for all areas;

- "#" means its price is based on the market prices;
- "-" means local price is not available;
- The price selection guideline is based on actual current market prices.

AVERAGE DAILY WAGES OF WORKERS FOR CONSTRUCTION INDUSTRY IN SELECTED CITIES OF CHINA (RMB)

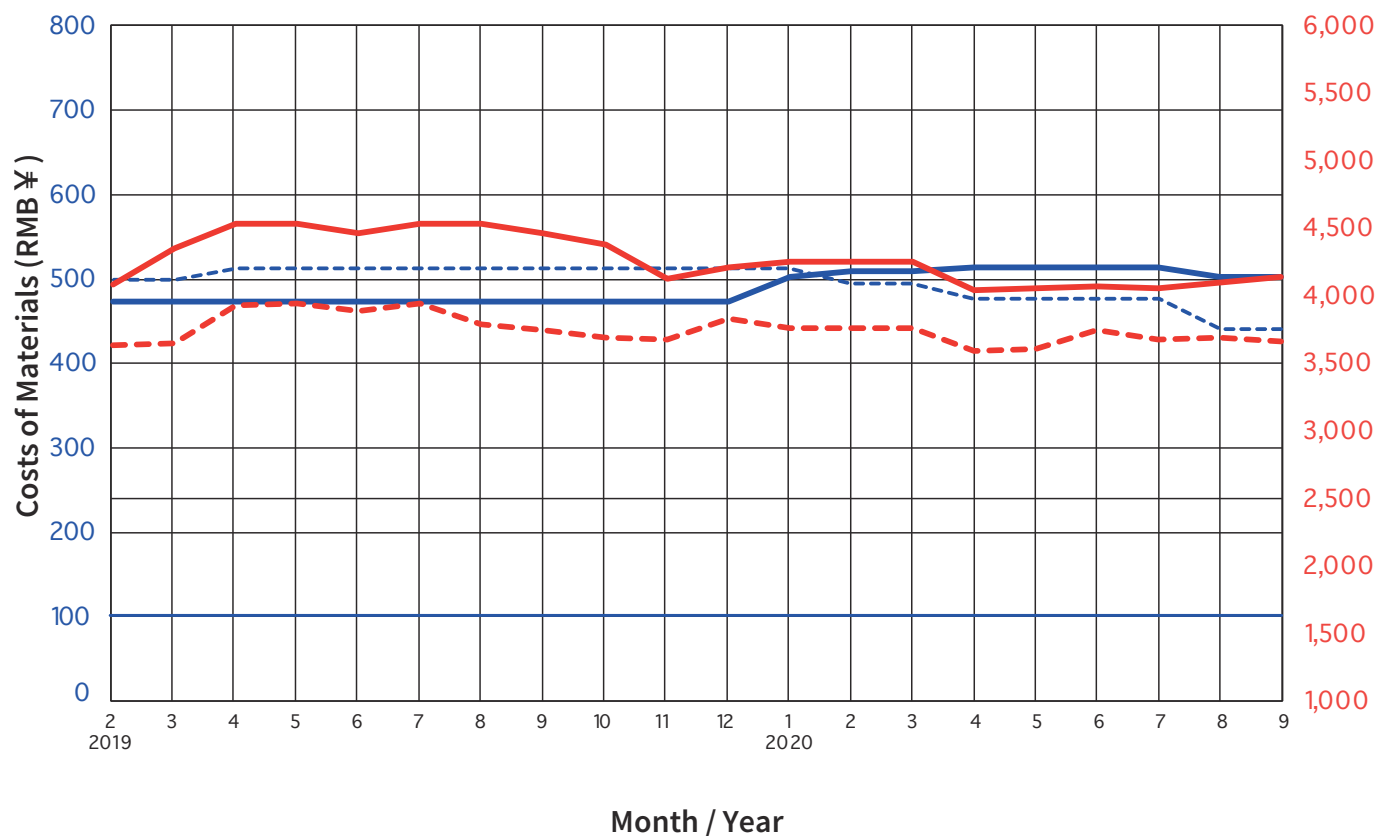
(3rd Quarter 2020 Prices)

Selected Trades (according to the general public standards)		Beijing	Chengdu	Chongqing	Guangzhou	Hangzhou	Nanjing	Shanghai	Shenyang	Shenzhen	Tianjin	Wuhan	Xian
1	Joiner (construction)	316	304	274	300	270	330	320	275	384 Decoration Joiner	320	257	315
2	Painter	293	222	244	279	247	297	380	253	342	280	196	253
3	Formwork erector	328	304	289	296	273	330	350	268	380	330	245	323
4	Plasterer (normal)	302	263	235	283	238	296	380	263	345	300	197	260
5	Bar Bender	298	295	273	290	259	313	340	239	363	330	226	320
6	Bricklayer (masonry)	302	270	235	279	277	300	350	261	357	320	219	317
7	E&M worker	270	187	233	287	237 Metalware worker	298 Metalware worker	350	243	334 Average plumber / electrician	330	204 Metalware worker	250
8	Concretor	266	216	240	267	231	294	320	204	345	300	207	245
9	Waterproofer	295	213	229	272	240	296	350	224	309	290	193	290
10	Plasterer (Surface)	373	246	260	294	250	312	390	270	374	390	210	280
11	Scaffolder	318	289	279	296	280	310	390	277	377	350	240	368
12	Welder	301	233	239	294	279	307	380	246	348	370	235	273
13	Rigger	278	199	198	265	245	292	330	248	328	260	215	230
14	Glazier	302	187	219	274	236	288	350	248	335	400	186	307
Average daily wage (1-14)		303	245	246	284	255	304	356	251	351	326	216	288

Notes:

1. Various types of daily wages are based on real-time construction market price. The data covers commercial, residential and industrial development projects; the wages are based on the weighted daily wages received from 2-4 contractors;
2. The above average daily wages include: basic wage, allowances, benefits, etc. i.e. all expense payable to workers;
3. Daily wage is based on 8 hours per day, excluding overtime allowance;
4. All trades are based on general labour.

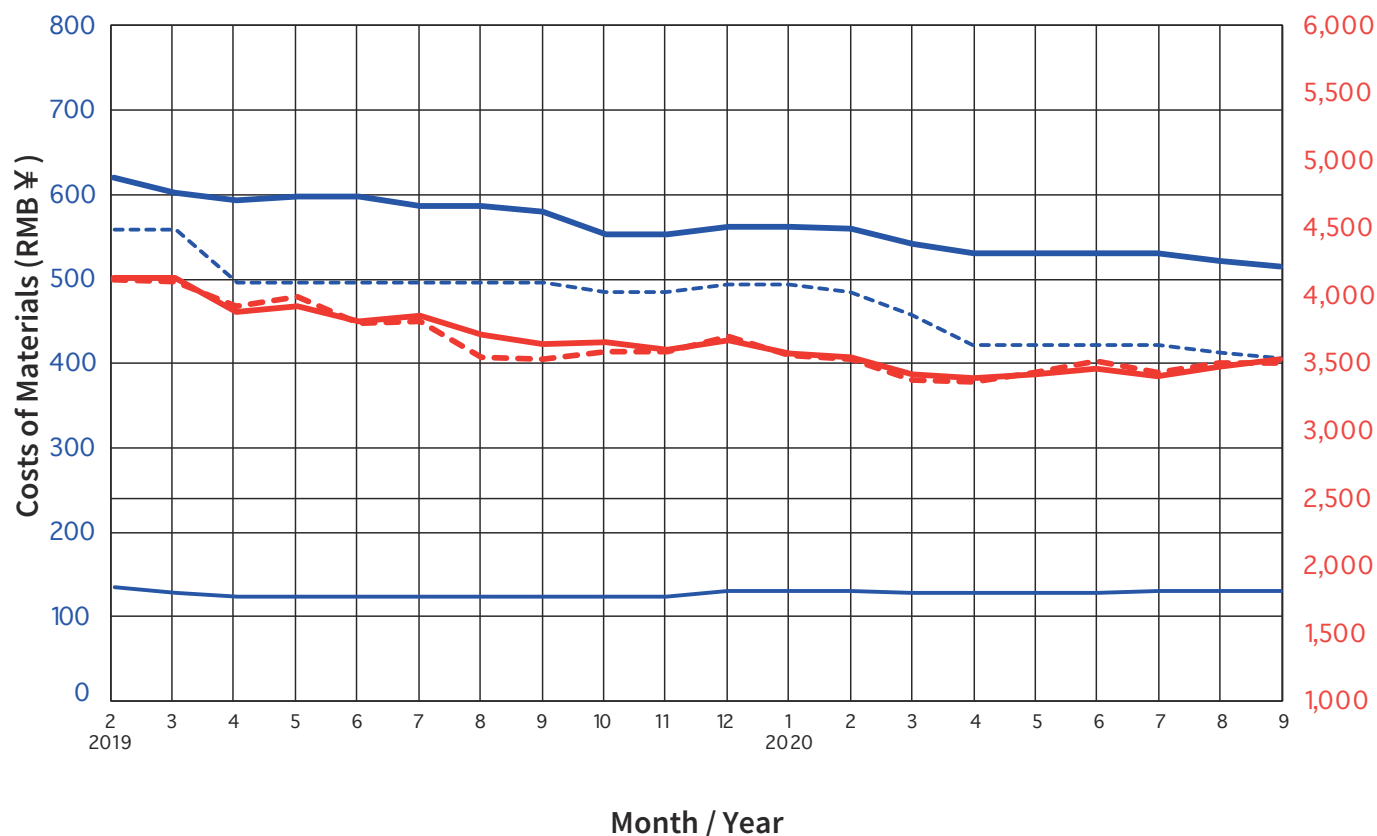
Wholesale Prices of Selected Building Materials in Beijing



Building Materials		Wholesale Prices of Selected Building Materials in Beijing																					
		2019												2020									
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
Reinforcement bar HPB235 (I) 10mm	¥/t	—	4,099	4,358	4,544	4,535	4,465	4,535	4,535	4,473	4,385	4,137	4,226	4,261	4,261	4,261	4,058	4,062	4,080	4,062	4,106	4,150	
Reinforcement bar HRB400 (III) 25mm	¥/t	---	3,647	3,655	3,938	3,956	3,894	3,956	3,805	3,752	3,708	3,690	3,841	3,770	3,770	3,770	3,611	3,619	3,752	3,690	3,699	3,681	
Portland cement Grade 42.5 (bag)	¥/t	500	500	513	513	513	513	513	513	513	513	513	513	496	496	478	478	478	478	443	443	
Reinforced concrete Grade C30 5-25 stone P8 waterproofing (without pumping fee)	¥/m ³	—	476	476	476	476	476	476	476	476	476	476	476	476	505	510	510	515	515	515	515	505	505
Sand (rough/mixed)	¥/t	—	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102

(Source: www.bjzj.net)

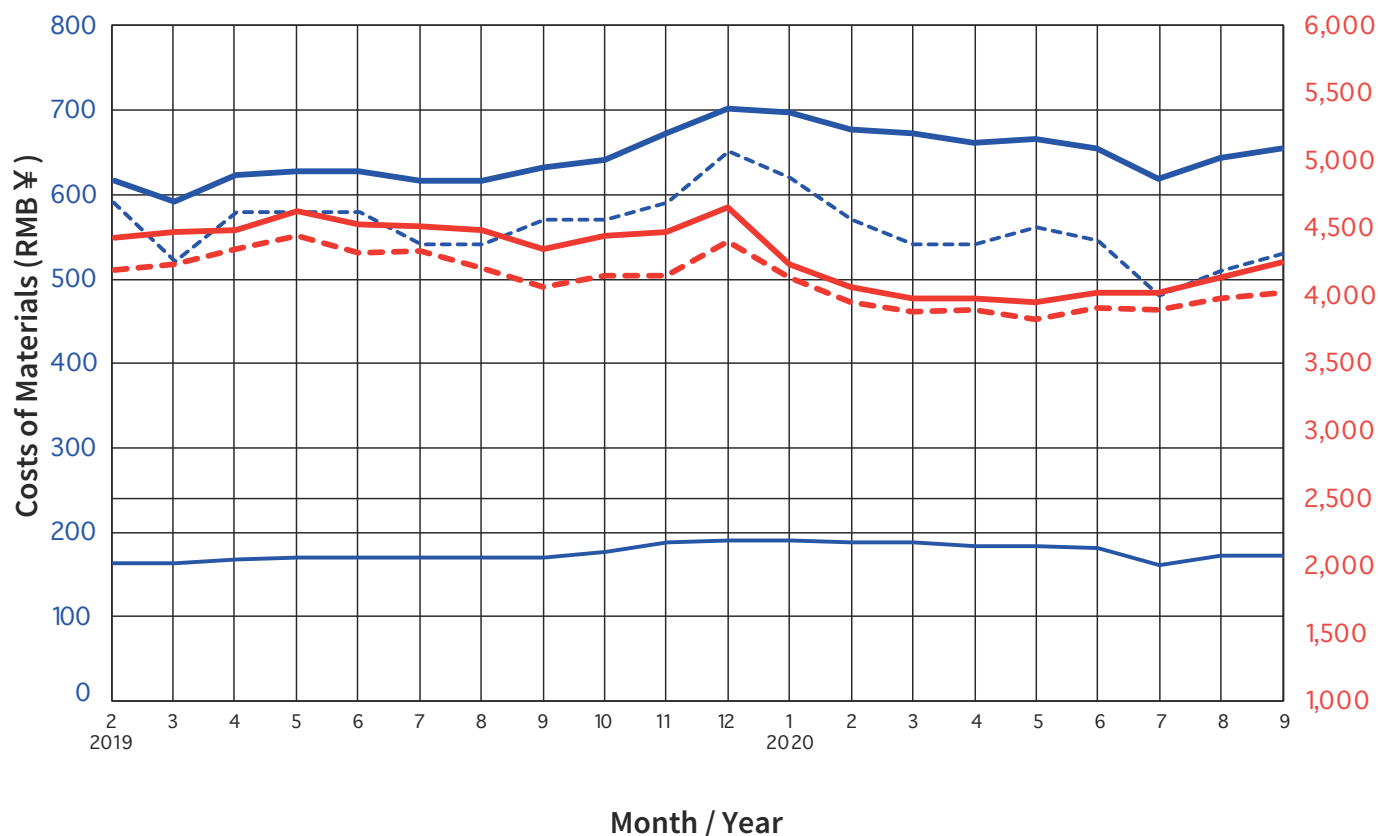
Wholesale Prices of Selected Building Materials in Chengdu



Building Materials		Wholesale Prices of Selected Building Materials in Chengdu																			
		2019												2020							
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Reinforcement bar HPB235 (I) 10mm	¥/t	4,126	4,128	3,876	3,918	3,797	3,836	3,706	3,637	3,640	3,590	3,655	3,556	3,529	3,408	3,386	3,402	3,447	3,393	3,471	3,520
Reinforcement bar HRB400 (III) 25mm	¥/t	4,107	4,101	3,914	3,983	3,789	3,800	3,535	3,523	3,575	3,582	3,682	3,554	3,521	3,373	3,351	3,426	3,500	3,427	3,493	3,493
Portland cement Grade 42.5 (bag)	¥/t	557	557	493	493	493	493	493	493	482	482	491	491	482	456	420	420	420	420	412	404
Reinforced concrete Grade C30 5-25 stone P8 waterproofing (without pumping fee)	¥/m ³	618	600	591	595	595	585	585	578	551	551	561	561	558	539	529	529	529	529	519	512
Sand (rough/mixed)	¥/t	133	127	123	123	123	123	123	123	123	123	130	130	130	128	128	128	128	129	129	129

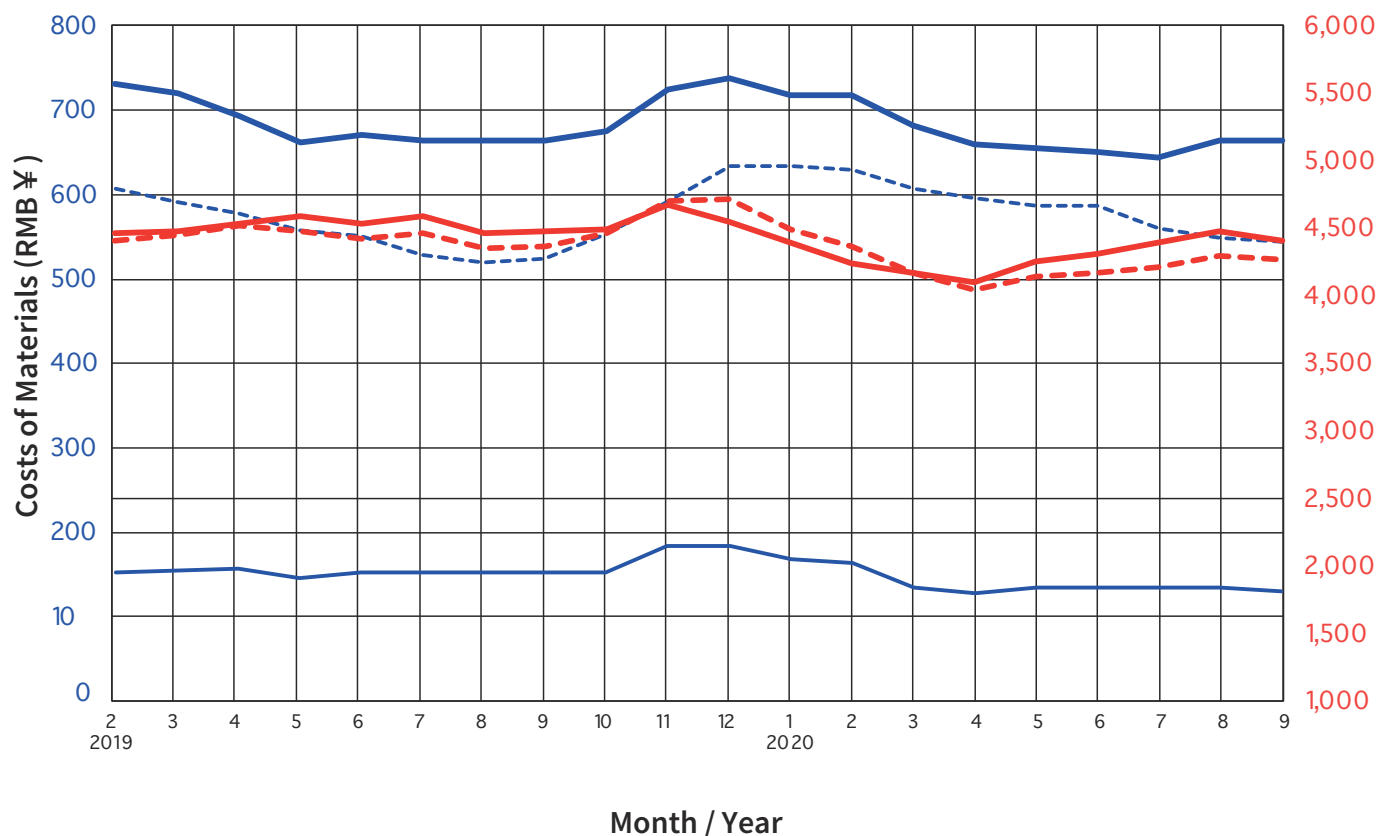
(Source: www.sceci.net)

Wholesale Prices of Selected Building Materials in Shanghai



(Source: <https://ciac.zjw.sh.gov.cn/>)

Wholesale Prices of Selected Building Materials in Shenzhen



Building Materials		Wholesale Prices of Selected Building Materials in Shenzhen																			
		2019												2020							
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Reinforcement bar HPB235 (I) 10mm	¥/t	4,456	4,465	4,521	4,585	4,529	4,577	4,448	4,463	4,487	4,669	4,534	4,387	4,234	4,154	4,086	4,239	4,294	4,388	4,464	4,402
Reinforcement bar HRB400 (III) 25mm	¥/t	4,391	4,439	4,506	4,464	4,406	4,456	4,338	4,354	4,459	4,686	4,703	4,488	4,357	4,163	4,035	4,130	4,164	4,206	4,287	4,261
Portland cement Grade 42.5 (bag)	¥/t	605	589	575	556	549	527	518	522	551	589	632	632	627	605	594	586	585	557	548	542
Reinforced concrete Grade C30 5-25 stone P8 waterproofing (without pumping fee)	¥/m ³	729	718	691	660	669	662	662	663	674	724	737	716	716	681	657	654	648	642	663	663
Sand (rough/mixed)	¥/t	149	152	154	144	150	150	150	150	150	182	182	165	162	133	126	132	132	132	132	128

(Source: www.szcost.cn)

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