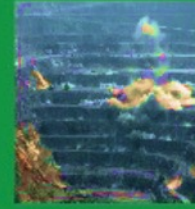
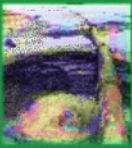


环保混凝土革命的未来



The Art of Lightweight Technology





BOEDIMAN WIDJAJA、黄忠仁先生-工商管理硕士
JOE Green Group创始人兼首席执行官

“用可再循环废料创造和开发环保的轻质骨料，这些再生骨料可减低全球气候变暖的挑战，以进一步建立未来可持续发展的环保计划。”

走向绿化  走向全球



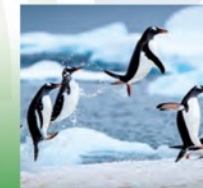
关怀与热诚

我们只有一个地球（JOE-仅有一个地球），我们必须保护好它防止因污染和对大自然的过度开发而引发全球变暖。

JOE Green是零废料制造商。所有生产废料与未通过质量控制的墙板将被再循环。

JOE Green是一家拥有ISO 14001:2015质量管理体系认证的公司，该证书有助于以可持续的方式保护我们的环境。此外，JOE Green在提高工厂效率、节约资源、减少浪费以及安全设计和优质墙体方面的表现也获得了ISO 9001:2015质量管理体系的认证。同时，以ISO 45001:2018质量管理体系为指导，以创建健康、安全的工作环境，以最大程度地减少失误和意外事故的发生。该认证符合新加坡安全之星证书(bizSAFE Star)的标准。

目前，JOE Green所生产的产品被公认为是一种环保且超高效的产品，并认证至少可使用占有原材料30%的再生混凝土骨料。我们的产品因在新加坡、马来西亚、柬埔寨和印度尼西亚的著名项目而受到新加坡和国际上著名的开发商、建筑师、专业顾问和承包商的信赖与推荐。



现在正是时候

据世界银行称：

2020年固体废物产生量22.4亿吨

据《科学》杂志和《自然》杂志报道：
每年使用 300 亿吨混凝土。

如何回收混凝土中的废料？

答案是  LiGrA™
Lightweight Green Aggregates



零浪费

LiGrA™ Lightweight Green Aggregates

碳排放量对社会和经济的影响



由于全球海平面上升而产生的海岸防护费用



由于全球变暖温度升高而导致工作能力下降



有限的资源掠夺而引发的战争



一些地区缺乏水源



引起城市整体的搬迁



经济作物产量下降



生活基本必需品价格上涨



极端的气候现象将导致贫困程度上升



由于全球变暖温度升高而引发的疾病



Coal Bottom Ash



Marine Clay



Demolition Waste



Bauxite Waste



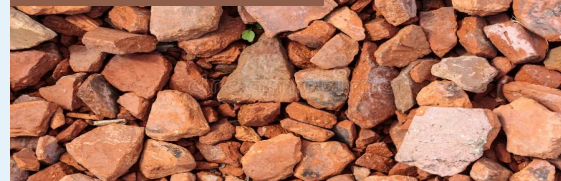
Ceramic & Porcelain



Glass Waste



Red Bricks



Roof Tiles



工业和消费废物

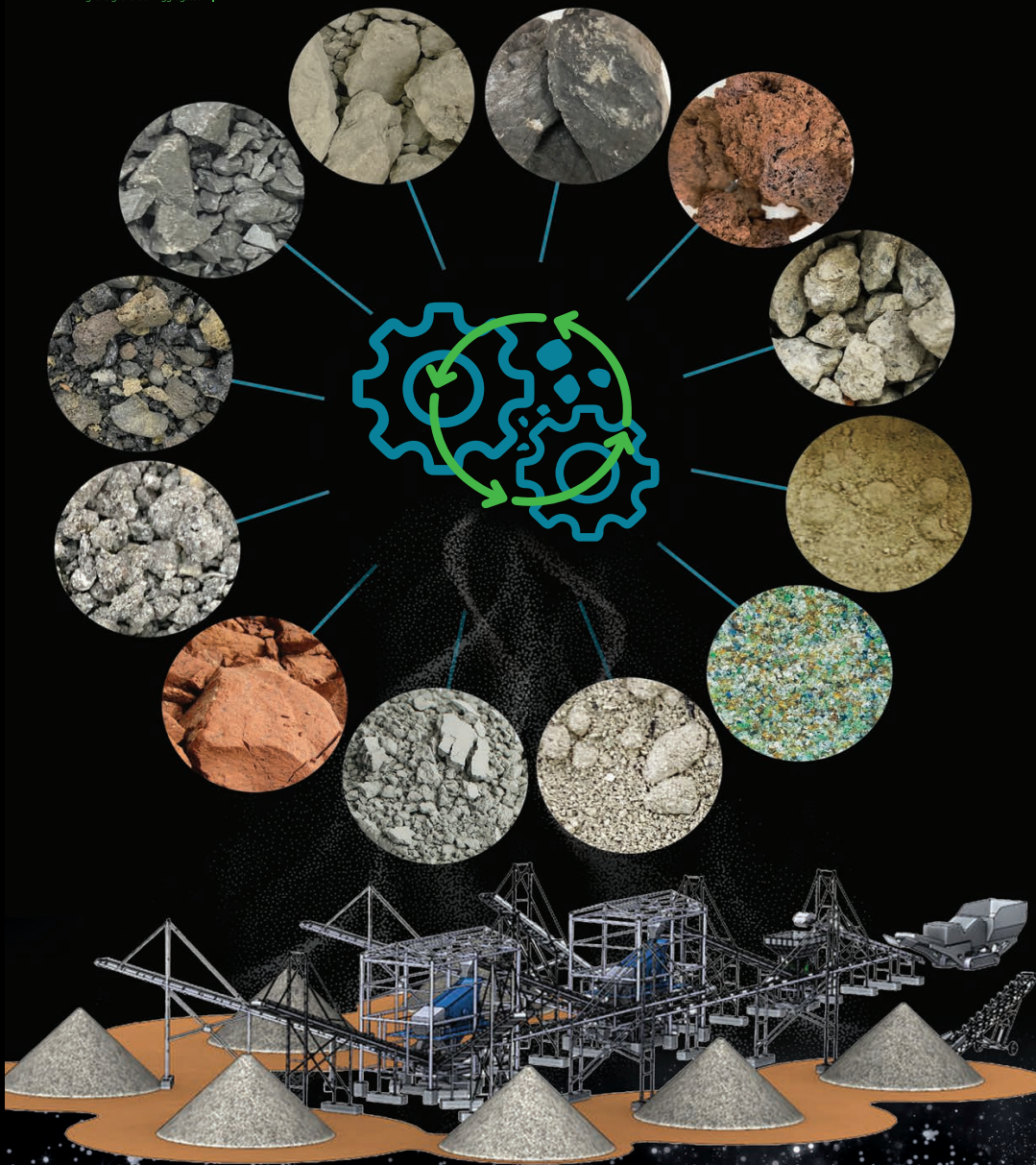
- ✓ 将无机废料转化为新的结构和非结构轻质绿色骨料 (LiGrA)
- ✓ 废物管理解决方案和回收成新材料
- ✓ 绿色建筑和人类安全使用的最先进技术，具有封装重金属和毒性的能力。



各类工业废料



回收利用



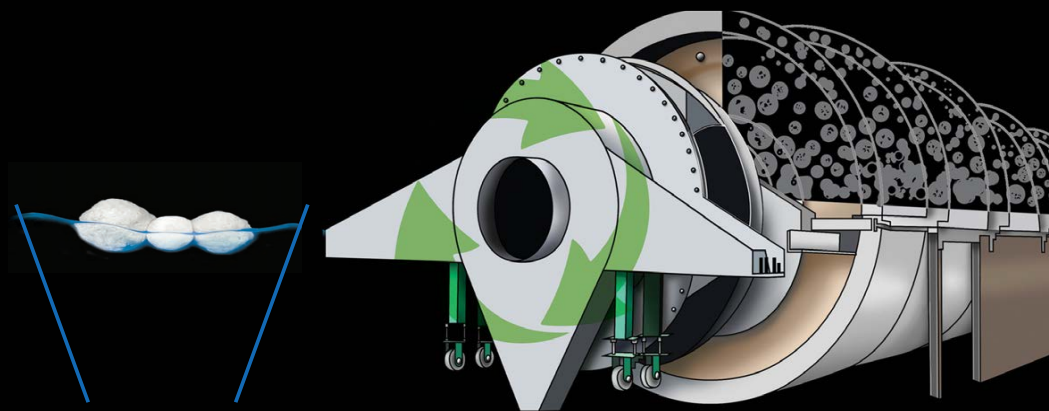
轻质绿色骨料工程



生产程序



我们与顶尖的创新制造商展开合作，以便开发出了低碳排放的高科技以及节能设备。



自有研发中心

- 使用废料的轻质骨料
- 轻质混凝土混合料设计和性能
- 减水剂 – 用于水泥和采石场粉
- 高吸水性 - 天然和合成
- 3合1涂料 – 脱脂、油漆底漆和防水
- 防水涂料
- 木塑复合材料
- 木质LWA复合材料



THE STRAITS TIMES | SATURDAY, SEPTEMBER 10, 2022



Joe Green's Lightweight Green Aggregates (LiGrA) building materials (above) are made from recycled waste. PHOTO: JOE GREEN

Smarter recycling, greener concrete

Joe Green

Concrete is the most widely used commodity in the world and supports the growth of cities through housing and infrastructure.

But it is bad for the built environment. According to German news agency Deutsche Welle, the manufacturing of more than four billion tonnes of cement is responsible for about 8 per cent of global carbon dioxide emissions – more than double the numbers notched up by global flying or shipping.

But what if there were greener ways to make concrete? That was the mission of Mr Boediman Widjaja, chairman and founder of Joe Green, a global group based in Singapore which manufactures innovative building materials for the precast wall business, the built environment and industrial applications.

One of its top-selling ranges is the Lightweight Green Aggregates (LiGrA) line of building materials such as panels and precast concrete. It is made from recycling waste materials such as ceramics, ash, sludge and glass – which, according to the latest report by Singapore's National Environment Agency, form only between 8 and 13 per cent of all waste recycled.

Research and development for

the manufacture of LiGrA started in 2015, with Joe Green staff collaborating with industrial and academic experts from countries including Japan, China, Russia and in Europe. The final product was ready in 2020. Joe Green now produces about 60,000 cubic metres per annum of LiGrA in the form of lightweight concrete aggregates.

The company displayed lightweight wall panels and structural and non-structural LiGrA products at BEX Asia.

Mr Widjaja, 60, graduated with a master's degree in business administration in 1989 from the Florida Institute of Technology in the United States, and has more than 20 years of experience in distribution and trading in South-east Asia, Europe and the US.

"The building materials available in the market today are manufactured from precious natural minerals such as clay, gravel, sand and shale, and imported from overseas. In producing LiGrA from waste, we not only solve the waste disposal problem, but also reduce the exploitation of natural minerals such as granite and sand," he says, adding that Singapore is one of the biggest importers of such natural resources to cater to the demands of the built environment.

Wednesday, December 07, 2022

THE STRAITS TIMES



Our economy is currently based on a linear production and consumption model in which resource wastefulness is inherent.

A major portion of goods post-consumption ends up in landfills or are incinerated which leads to significant economic losses. Also, this leads to over exploitation of the environment thereby posing a threat to the planetary boundaries.

The solution lies in moving to a circular economy. It will lead to a reduction in waste generation and also reuse the generated waste. Thus, reducing the environmental pressure through the reduction in the rate of extraction of raw materials. This also offers benefits in terms of value retention in otherwise waste or under-utilized materials.

JOE Green had foreseen the need for sustainable and circular economy under the 3R Green Concept since its inception 2006 into Precast Hollow core Wall Panel Business. Reduce, Reuse, Recycle.

Our products with hollow core profiles had help reduces: Raw material content by more than 30%, coupled with usage of blasted furnace slag further reduced more than 20% reliance of OPC usage, 50% content of mineral end tail waste from granite quarry – manufactured sand in replacement to concrete sand extracted from natural resources.

Recovery of other industrial waste & transforming to New Lightweight Green Aggregate- LiGrA.

These contributes to lighten up building dead loads, lower carbon footprint. Savings in foundation design, Cost & time with higher productivity and performances.

Since 2015, with more focus on Green Effort and continue its vision to be a Green Builder and Zero Waste Manufacturer. Our journey begins with R&D into carbon neutralizing projects, searching for ultimate solution to manufacture light-weight green aggregate from waste and create a sustainable circular economic built environment.

With successful R&D results, JOE Green commences its venture into setting up an innovative plant to recycle waste into new materials as Light weight Green Aggregate – LiGrA for various industries applications.

Having its new Manufacturing Plant commissioning in Q3 2022 under operation of Gramata Fordea, JOE Green's Green Effort would lead the group of companies into the New Era of achieving its ESG policies and Sustainable Development Goals.



JOE GREEN MARKETING PTE LTD

THE ART OF LIGHTWEIGHT TECHNOLOGY

JOE Green is especially honoured and privileged to have the opportunity to be named once again as one of the top 50 SMEs in the 2022 - E50 Awards. We are grateful and blessed to be able to receive such a prestigious award, we are humbled.



We hope to take this opportunity and spotlight to be able to create a positive difference for the building, construction, and material for a greener and brighter future. In addition, we wish to have this prestige award, we could attract more customers and stakeholders to join our Green projects to save our Just One Earth.

businessstimes.com.sg/singapore/smes/joe-green-makes-concrete-go-green?session-refresh=1

THE BUSINESS TIMES

ENTERPRISE 50

Published Thu, Mar 02, 2023

Joey Kang, Ng Yan Bin, Phua Wei Lin

Joe Green makes concrete go green

WHAT do the upcoming public flats in Tengah estate have in common with Changi Airport's Jewel? The answer may not be immediately visible, but it is central to both developments: their eco-friendly precast concrete walls, supplied by Joe Green Marketing.

The company is a registered Housing and Development Board supplier, and its precast panels are used in over a thousand residential, industrial and commercial buildings in Singapore. Besides being physically lightweight, Joe Green's hollow-core concrete panels are light in terms of environmental impact, as they are made from recycled materials.



Joe Green Marketing's founder and managing director Boediman Widjaja (right) and marketing director Charlina Lim at the Enterprise 50 Awards in 2021.
PHOTO: JOE GREEN MARKETING

THE BUSINESS TIMES

Wednesday, May 03, 2023

Moving light, but with strength: Joe Green sees potential in hi-tech recycled building materials

With new Ligra product, founder Boediman Widjaja seeks to set an eco-friendly example for the industrial waste and construction sector.

BY CHLOE LIM

BUILDING materials manufacturer Joe Green is committed to a zero-waste manufacturing process. Its concrete panels are made of recycled materials, and waste or residual material from the manufacturing process is also reused.

The result of this process is a panel that is both sustainable and lightweight, allowing Joe Green's end customers to build green buildings at lower costs both financial and environmental.

But Joe Green, which was founded in 2006 by Boediman Widjaja, is now facing competition from other building materials companies that are also keen to offer lightweight products. One example is autoclaved aerated concrete walls, which contain air pockets to make them lighter.

So, what will continue to set Joe Green apart? Widjaja, who is both chairman and managing director, is looking to the company's lightweight green aggregate (Ligra) product – the fruit of several years of research and development.

Enter Ligra

Joe Green's Ligra development dates as far back as 2015, as the company considered ways to stay ahead of the competition. "We knew that we had to further improve our own product to truly stand out in the market in the long run, because just being lightweight (at some point) was not enough," said Desmond Ng, technical director at Joe Green.

More than just lightweight and environmentally friendly, Ligra boasts strength and durability. These two factors tend to be compromised in lightweight materials, said Widjaja.

"Lightweight products in the market these days tend to end up very porous, which could compromise the final solid nature of the panel eventually," he said.

Water could end up seeping into wall panels more easily, and create a more drying texture in the long run.

Widjaja said Joe Green's Ligra panels prioritise density and firmness without compromising on the lightweight element.

In its development, Joe Green faced the challenge of sourcing raw materials. "To produce lightweight aggregates, one would need to import them, said Ng.

"We needed to find the best and nearest source (of such material) and ensure that these supply chains were stable."

This turned out to be difficult. "Most neighbouring countries, such as Malaysia and Indonesia, are not (consistently) working on lightweight aggregates," Ng said.

The company could have been sourced for these materials in further markets, such as China, India or Thailand. "But the high costs of imports did not make sense for us," he added.

In addition, many of these lightweight aggregates did not

meet Joe Green's standards, as they did not come from natural sources. So, in 2017, Joe Green started its own inventory of aggregates instead.

These materials have been or are being used in various projects: residential ones such as the up-and-coming Tengah estate, healthcare buildings from National University Hospital to Sengkang General Hospital, and local universities such as the National University of Singapore (NUS), Nanyang Technological University and Yale-NUS College.

"As Ligra continues to be lightweight, transport of the material continues to be cheaper, which saves on overall costs as well," Ng said.

"With buildings made from Ligra, the dead load of the entire building will be 30 per cent lighter, which means now reinforcements can be lighter as well."

Construction processes are also sped up, and hence more efficient, he added. "Furthermore, in that process, a lower dead load due to less concrete (mass) used brings down the carbon footprint as well."

Joe Green has begun mass producing Ligra at its factory in Johor, as the company prepares to promote Ligra with market partners this year. Said Widjaja: "Within this year, we are expecting to see a good response to the product."

A key R&D focus

The "continuous investment" in

research and development (R&D) that has made Joe Green's Ligra product possible has been a core component of the company's activities, said Ng.

"While Ligra has been a main focus in our R&D work, we also spend time and effort improving the systems and operations behind our products," he said. This may take the form of improving existing precasting structures and making lighter 3D-printed products.

"It's always good to sell the standard panel; but in the past, we've received feedback that we were not serving enough customisation needs," Ng said. "So, from 2015, we've been working on more custom options of our panels, to offer various sizes and material types."

With Ligra, wall panels can be made solid or hollow, for example, in the event that wires need to be inserted within the wall. Ng said customised offerings have minimised risks in the construction process and reduced wastage by 5 per cent.

With potential enhanced margins from Ligra, the team at Joe Green is hopeful that more resources can be allocated for R&D.

A 'revolution' for the concrete industry

Ng is looking forward to continuing Joe Green's development of Ligra.

"There will be different models," he said. "Ligra is made from waste glass. We hope to treat bottom ash to make Ligra in the future."



JOE Green's Lightweight Green Aggregates (Ligra) (below) building materials are made from recycled waste. The company has started mass-producing Ligra at its factory in Johor (above), as it prepares to promote the product with market partners this year. PHOTOS: JOE GREEN



It may take some time for Joe Green's product to win over customers, though. "Added costs must be justifiable," Ng said. "But we are sure that market recognition will come quickly for us."

A recent report by French multinational Schneider Electric and the Singapore Green Building Council said 61 per cent of business leaders cited cost and return on investment as their biggest concerns when it comes to green building adoption.

At the same time, an overwhelming 95 per cent of respondents agreed that 80 per cent of Singapore's buildings should be "green" by 2030.

The report surveyed more than 500 business leaders across 340 multinational corporations and

"While Ligra has been a main focus in our R&D work, we also spend time and effort improving the systems and operations behind our products."

Desmond Ng, technical director JOE Green

Benefits of lightweight green concrete and aggregates

LIGHTWEIGHT GREEN CONCRETE

- Saving in construction cost and time
- Saving in handling and transportation cost
- Saving in foundation cost
- More durable structures
- Higher earthquake resistance
- Longer building service life
- Bigger space savings between columns
- Lintel & stiffener joint cost savings
- Lower crane capacity
- Energy savings benefits
- Sustainable environments built

LIGHTWEIGHT GREEN AGGREGATES

- Extra lightweight and strong
- 100% biodegradable and recyclable
- Environmentally friendly
- Lower carbon footprint
- Economic and competitive
- No hazards to health
- Non combustible
- High resistance to fire
- Good thermal insulation
- High acoustic insulation
- Low water absorption

Recycled lightweight concrete advantages over normal weight concrete

- Internal and external curing
- Strong interface between aggregate and cement
- Modulus compatibility of aggregate and cement
- Continuous strength gain
- Lifelong durability
- Uniform stress distribution

SOURCE: JOE GREEN
GRAPHIC: BT VISUAL

and Malaysia, the company has a plant in Jakarta, Indonesia.

It plans to target every major city in Indonesia.

"Considering Indonesia's sizeable population of over 250 million people, we hope to better tap the market by building a plant in each of Indonesia's major cities, in a bid to move beyond Singapore's market, which is comparatively much smaller," said Widjaja.

He is also entertaining the possibility of going global, having had recent conversations with potential partners in China and Dubai.

"However, it's not easy to get good commercial terms on these fronts (as yet); so this continues to be a work in progress," he added.

"I daresay that Ligra is set to revolutionise the concrete industry," Widjaja said.

"As we move light but strong with this new technology, we are on track to setting an example of strength for the industrial waste and construction sector while emphasising environmental responsibilities."

chloe.lim@sph.com.sg

This is the first of a 5-part Green Business series, in collaboration with UOB, exploring sustainability trends across businesses and industries.

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2023年05月11日 星期四



zaobaosg

在商业领域中，可持续发展不仅仅是会影响企业长期生存和发展的关键因素，也是企业对社会的一种责任。《永续经营·造福未来》系列访问研发可持续材料或采纳可持续商业做法的各领域企业，了解它们如何克服挑战和掌握可持续发展的机遇，在当前和未来从中获益，并造福社会。

开发环保科技轻质骨料 打造零污染绿色建筑

“

最早的六年我们连续承担极大的亏损，我家人和朋友甚至叫我放弃，但是我丝毫没有退却。

”

■ 卢丽珊

一个企业家的坚定信念，引领本地零废料制造商公司排除万难，走向可持续发展和绿化区域与全球建筑业的旅程。

2006年，总裁黄忠仁（61岁）在新加坡注册JOE Green公司并设厂，当时赶上本地建筑业开始转型使用预制水泥墙板，建设局亦鼓励建筑业者减少使用或取代传统耗时、须要窑烧的高污染红砖。

由于竞争者极少，他看准商机在本地设厂生产预制水泥墙板。目前该公司是本地最大的预制水泥墙板供应商之一，它研制的空心水泥墙板应用于区域和本地的建筑项目。

在本地已完成1000多个工商业、私人住宅、政府组屋和地铁建筑项目，包括星耀樟宜，以及新加坡国立癌症中心和盛港综合医院等多家医院，2013年则进军政府组屋的建设。

然而，黄忠仁志的努力不仅仅于此，他通过高科技循环废料，生产绿化预制水泥墙板，后期更成功研发与生产这些水泥墙板的原料——绿化轻质骨料（LiGrA, Lightweight Green Aggregates），为更广大的建筑业者提供替代原料。

然而这一路走来却险阻重重。

首先，出生于印度尼西亚的黄忠仁前半生在印尼和本地是成功的电脑代理商，中年改换跑道，进入建筑业的绿化工程领域，之后从零开始学习。

公司最初在大士一带租用厂房，岂料2007年印尼宣布禁生产水泥墙板的原料：沙石。这让黄忠仁下定决心，加快研发循环废料作为生产原料的方法。

他忆述：“最早的六年我们连续承担极大的亏损，我家人和朋友甚至叫我放弃，但是我丝毫没有退却。为了节约成本，我们在2011年将厂房搬到马来西亚。”

厂房设于柔佛州士乃，投资900万新元建造3.5公顷的厂房，添购捣碎设备，对工业废料例如瓷砖和墙板进行捣碎和处理。

以轻质科技生产绿色原料

这一年它们成功研制可再生水泥骨料（Recycled Concrete Aggregates），跻身零废料制造商之列，并以此生产预制空心水泥墙板，结果成为获颁新加坡绿色建筑协会符合四个勾级别的首几名分业者之一。

公司的名称JOE（Just One Earth）秉承绿色使命：我们只有一个地球。黄忠仁说：“我们必须保护地球，减缓对环境的影响和损耗，尤其是在建筑业。”

建筑业是碳足迹最高的行业之一，占全球四成的碳排放量，三分之一来自生产建筑材料，如钢铁、水泥和玻璃。建筑使用的混凝土还需要其他原材料，例如沙石或花岗石，开采过程中需要远程运输，加深碳排放量。

水泥是地球上使用最广泛的物质，但水泥行业约占全球变暖和二氧化碳排放量的8%——远远超过全球航空业的碳排放量。

JOE Green在设计与生产预制空心水泥墙板时，减少大约40%所需原材料，并使用30%以上由工业废料生产的可再生水泥骨料构成。

接下来，JOE Green朝向可再生轻质科技发展。它们向国外进口轻质骨料生产可再生轻质墙板，到了2015年自己开发科研工作，以工业废料玻璃来生产绿化轻质骨料。

通过大华银行提供的资金，JOE Green得以调配资源来发展旨在实现业务可持续发展的研发计划。大华银行目前仍持续与该公司合作，配合它的业务发展需求。

公司在2017年在马来西亚工厂附近购地准备第二间厂房生产。岂料疫情打断一切进度，直到2022年厂房才完工启动生产，截至今年第一季，绿化轻质骨料已经为各领域业者，例如预拌混凝土业者、水泥预制件业者、化工行业等进行产品测试，为它们提供绿化轻质骨料，作为生产绿化产品的原料。

这些绿化轻质骨料将进一步做成轻质预制件（墙板），它的重量更轻、耐用、隔热以及抗震，建筑物因此能有更长的寿命、节省空调功耗以及建筑物的冷凝。

公司也能根据个别工程所需，制成更大、更轻的预制构件，大大减轻运输燃料消耗，在装置过程中降低起重容量，因构件更大也加快施工进度，大幅度减低碳足迹。

小颗粒大愿景

JOE Green目前在本地、马来西亚和印尼稳健发展，目前已在首都雅加达拥有厂房。

公司也朝向区域化和国际化发展，许多国家如中国、越南、印度、中东和非洲国家都表示有兴趣，公司将从中找到合适的合作方案，包括技术转移或其他策略性合作。

黄忠仁强调：“尤其是那些产生大量工业废料的国家，都能够设立LiGrA厂房；这些工业废料包括煤灰（炉渣）、铝土矿废料（赤泥）、玻璃或瓶罐、瓷砖和海洋粘土。”

在本地，我国目前只循环大约15%的玻璃废料，还有85%的废料有待转换为有用的可再生产品，开发的极大。

在政府推动的绿色建筑蓝图下，JOE Green不断加强和本地材料回收设施和政府部门例如国家环境局，以及环境、社会和治理方面（Environmental, Social, Governance）的合作和参与。



JOE Green创办人兼总裁黄忠仁：做生意不能仅是为了盈利，而是要衡量现在和未来的需要。（特约摄影谭淑慧）

眼下它们希望向环境局成功取得营业执照进行玻璃废料循环工程，运用公司的技术进行玻璃废料循环。

在他眼中，保护环境是这个世代的责任。“做生意再也不能仅是为了盈利，而是衡量现在和未来的需要。我们要为下一代留一个更绿化、可持续发展的环境。

“毕竟我们只有一个地球。”



Worldwide, Buildings Account for 40% of Global Energy Consumption and 33% of Greenhouse Gas Emission



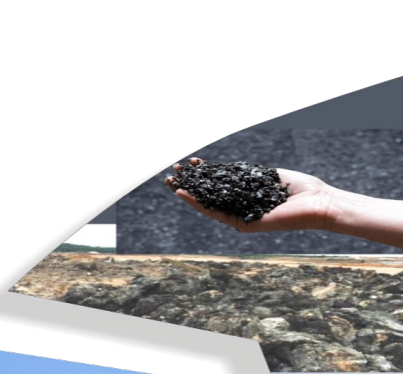
JOE Green has a Plan to Decarbonise the Industry, With a focus of Sustainability



Lightweight Green Aggregate (LiGrA) is Made from Recycled Waste, Help to reduce CO2 Emissions, Resource use and Construction costs.



JOE Green is Continuously Developing other products, with the aim of Reducing Emissions, Manpower, Resource use and Energy Inefficiency.



Bottled Glass

Waste Glass crushing

Recyclable Industrial Wastes



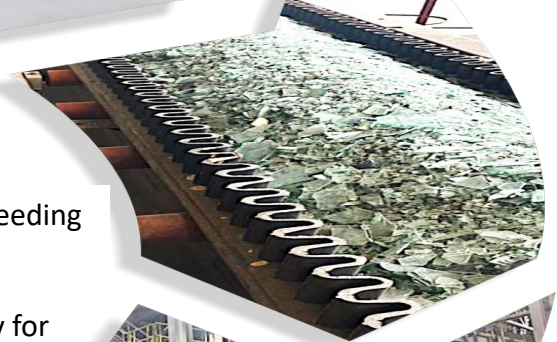
Demolition Waste



Net-Zero

Reduce Carbon Footprint/Emission

Waste Glass Feeding



Factory Technology for Aggregates Production

Building



Precast Component/Ready Mix



Various Lightweight Green Aggregates (LiGrA)



可持续发展解决方案 LiGrA:

Bauxite waste (Red Mud) & Coal Bottom Ash

Raw material

Lightweight Green Aggregates (LiGrA)



进行填埋处理



Lightweight Green Concrete



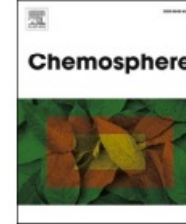
Chemosphere 307 (2022) 135895



Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere



Recycling municipal solid waste incineration fly ash in super-lightweight aggregates by sintering with clay and using SiC as bloating agent

Siyu Han, Yingchun Song, Tongya Mengdan Liu, Jinglin Li, Jianguo

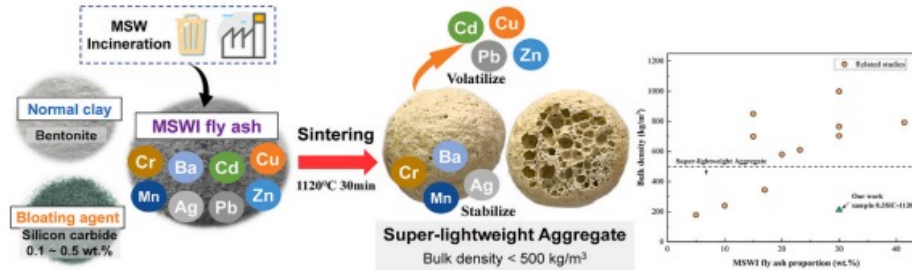
School of Environment, Tsinghua University, Beijing 100084



● Risk of heavy metal leaching toxicity has been mitigated after sintering.

HIGHLIGHTS

- SiC was applied as bloating agent to produce LWA with MSWI fly ash.
- Super-lightweight aggregate could be produced by adding 0.1–0.5 wt% SiC.
- Effects of SiC addition and sintering conditions were studied in detail.
- Risk of heavy metal leaching toxicity has been mitigated after sintering.
- Formation of complex diopside-based phase during sintering was revealed.



烧结包封毒性的有效性 Coal Bottom Ash Waste

Client's Name : JOE GREEN PTE LTD
Sample Ref. : COAL POWER PLANT BOTTOM ASH

Client's Name : JOE GREEN PTE LTD
Sample Ref. : CONCRETE MORTAR WITH 100% COAL POWER PLANT BOTTOM ASH

Client's Name : JOE GREEN PTE LTD
Sample Ref. : BOTTOM ASH - LIGHT WEIGHT AGGREGATE

Test Items	Result ⁽¹⁾	Unit	Test Method	Maximum Allowable Concentration (mg/L) ⁽³⁾	Met Criteria
Arsenic (As)	< 0.1	mg/L	EPA 1311:1992 / EPA 6020B:2014	5	Yes
Barium (Ba)	0.4	mg/L		100	Yes
Cadmium (Cd)	< 0.1	mg/L		1	Yes
Chromium (Cr)	< 0.1	mg/L		5	Yes
Copper (Cu)	< 0.1	mg/L		100	Yes
Iron (Fe)	< 0.1	mg/L		100	Yes
Lead (Pb)	< 0.1	mg/L		5	Yes
Manganese (Mn)	0.1	mg/L		50	Yes
Nickel (Ni)	< 0.1	mg/L		5	Yes
Selenium (Se)	< 0.1	mg/L		1	Yes
Silver (Ag)	< 0.1	mg/L		5	Yes
Zinc (Zn)	0.1	mg/L		100	Yes
Mercury (Hg)	< 0.01	mg/L		0.2	Yes
Phenol Compounds (as Phenol)	< 0.01	mg/L	EPA 1311:1992 / HACH 8047	0.2	Yes
Total Cyanide (as CN ⁻)	< 0.01	mg/L	EPA 1311:1992 / HACH 8027	10	Yes
Fluoride (as F ⁻)	< 0.1	mg/L	EPA 1311:1992 / APHA 4500-F C	150	Yes

Remarks:

- (1) < refers to 'less than'.
- (2) Leaching Test - NEA Recommended acceptance criteria for suitability of industrial wastes for landfill disposal.
- (3) The above results were tested as per sample submitted by client.
- (4) Conformity statement reported with no decision rule applied. Uncertainty of measurement available on request.

Test Items	Result ⁽¹⁾	Unit	Test Method	Maximum Allowable Concentration (mg/L) ⁽²⁾	Met Criteria
Arsenic (As)	< 0.1	mg/L	EPA 1311:1992 / EPA 6020B:2014	5	Yes
Barium (Ba)	0.7	mg/L		100	Yes
Cadmium (Cd)	< 0.1	mg/L		1	Yes
Chromium (Cr)	0.1	mg/L		5	Yes
Copper (Cu)	< 0.1	mg/L		100	Yes
Iron (Fe)	< 0.1	mg/L		100	Yes
Lead (Pb)	< 0.1	mg/L		5	Yes
Manganese (Mn)	< 0.1	mg/L		50	Yes
Nickel (Ni)	< 0.1	mg/L		5	Yes
Selenium (Se)	< 0.1	mg/L		1	Yes
Silver (Ag)	< 0.1	mg/L		5	Yes
Zinc (Zn)	0.1	mg/L		100	Yes
Mercury (Hg)	< 0.01	mg/L		0.2	Yes
Phenol Compounds (as Phenol)	< 0.01	mg/L	EPA 1311:1992 / HACH 8047	0.2	Yes
Total Cyanide (as CN ⁻)	0.020	mg/L	EPA 1311:1992 / HACH 8027	10	Yes
Fluoride (as F ⁻)	0.5	mg/L	EPA 1311:1992 / APHA 4500-F C	150	Yes

Remarks:

- (1) < refers to 'less than'.
- (2) Leaching Test - NEA Recommended acceptance criteria for suitability of industrial wastes for landfill disposal.
- (3) The above results were tested as per sample submitted by client.
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Test Items	Result ⁽¹⁾	Unit	Test Method	Maximum Allowable Concentration (mg/L) ⁽²⁾	Met Criteria
Arsenic (As)	< 0.1	mg/L	EPA 1311:1992 / EPA 6020B:2014	5	Yes
Barium (Ba)	< 0.1	mg/L		100	Yes
Cadmium (Cd)	< 0.1	mg/L		1	Yes
Chromium (Cr)	< 0.1	mg/L		5	Yes
Copper (Cu)	< 0.1	mg/L		100	Yes
Iron (Fe)	< 0.1	mg/L		100	Yes
Lead (Pb)	< 0.1	mg/L		5	Yes
Manganese (Mn)	< 0.1	mg/L		50	Yes
Nickel (Ni)	< 0.1	mg/L		5	Yes
Selenium (Se)	< 0.1	mg/L		1	Yes
Silver (Ag)	< 0.1	mg/L		5	Yes
Zinc (Zn)	< 0.1	mg/L		100	Yes
Mercury (Hg)	< 0.01	mg/L		0.2	Yes
Phenol Compounds (as Phenol)	< 0.01	mg/L	EPA 1311:1992 / HACH 8047	0.2	Yes
Total Cyanide (as CN ⁻)	< 0.01	mg/L	EPA 1311:1992 / HACH 8027	10	Yes
Fluoride (as F ⁻)	0.1	mg/L	EPA 1311:1992 / APHA 4500-F C	150	Yes

Remarks:

- (1) < refers to 'less than'.
- (2) Leaching Test - NEA Recommended acceptance criteria for suitability of industrial wastes for landfill disposal.
- (3) The above results were tested as per sample submitted by client.
- (4) Conformity statement reported with no decision rule applied. Uncertainty of measurement available on request.

强大的运营和生产设施



最先进的生产设施



年产量

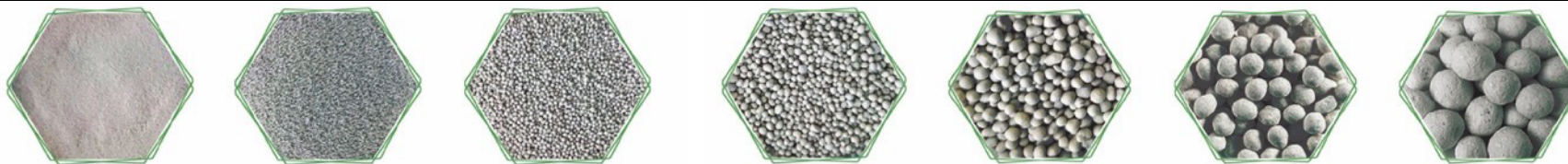
60,000 M³



优质材料
属性和性能



高效且高度
优质生产设施



ZERO
WASTE MANUFACTURER

零废物制造

Properties	Mikron 0.1	Mikron 0.25	Mikron 0.50	Mikron 1
Grain size [mm] ⁽¹⁾	0.1 – 0.25	0.25 – 0.5	0.5 – 1	1 – 2
Bulk Density in [kg/m ³] ⁽²⁾ (± 50)	420	360	290	250
Effective particle density [kg/m ³] ⁽³⁾ (± 50)	1050	790	550	450
Bulk crushing resistance [N/mm ²] ⁽⁴⁾ (± 10%)	4.7	3.3	3.1	2.6
Softening point [°C]	860/1250			
Melting point [°C]	1250 – 1500			
Thermal Conductivity [W/ (m.k)] ⁽⁵⁾	< 0.07			
Water absorption % by mass (± 20%)	30			
Colour	Light creamy white			
pH value	7 – 12			
Grain form	Sphere			

Note: More than 90% of the Lightweight Aggregates (LWA) falls within the specified size.

1) Technical data given after testing basic grain sizes according to EN 13055 – 1:2016/AC: 2016

2) Manufacturing tolerance

3) According to EN 1097 – 6: 2013

4) According to EN 13055 – 1: 2016

5) According to EN 12939: 2002

The properties shown on this data sheet represent typical average results generated using standard test method, conducted under controlled conditions and cannot be considered to be guaranteed specifications. Properties are subject to normal manufacturing statistical standard deviation ranges and the company reserves the right to modify the properties and specifications at any time without prior notice.

Properties	LD	HD (Low)	HD (High)	Fahrenheit
Grain size [mm] ⁽¹⁾	3-8			
Bulk Density in [kg/m ³] ⁽²⁾ (± 50)	200	600	800	150
Effective particle density [kg/m ³] ⁽³⁾ (± 50)	320	1000	1250	270
Bulk crushing resistance [N/mm ²] ⁽⁴⁾ (± 10%)	1.8	12.5	21	0.6
Softening point [°C]	860			
Melting point [°C]	1250 – 1500			
Thermal Conductivity [W/ (m.k)] ⁽⁵⁾ (± 10%)	0.07	0.12	0.18	0.06
Water absorption % by mass ⁽⁶⁾	< 30	< 8	< 5	< 40
Colour	Off white			
pH value	7 – 12			
Grain form	Sphere			

Note: More than 90% of the Lightweight Aggregates (LWA) falls within the specified size.

1) Technical data given after testing basic grain sizes according to EN 13055 – 1:2016/AC: 2016

2) Manufacturing tolerance

3) According to EN 1097 – 6: 2013

4) According to EN 13055 – 1: 2016

5) According to EN 12939: 2002

6) According to EN 1097 – 6: 2013

The properties shown on this data sheet represent typical average results generated using standard test method, conducted under controlled conditions, and cannot be considered to be guaranteed specifications. Properties are subject to normal manufacturing statistical standard deviation ranges and the company reserves the right to modify the properties and specifications at any time without prior notice.

应用领域



PPVC & PBU Precast



Lightweight Building Materials



Lightweight Ready-Mix, Concrete & Industrialised Building System (IBS)



Hydroponic Media



Thermal Insulation (Roofs, Floors, Fire Doors)



Floating Concrete & Structure



Insulation of Pipeline in Oilfield



Lightweight Fillers for Ceramic and Polymeric Products



Filtration Media



Heat Resistant Plaster & Dry Mortar



Geotechnical Applications (Retaining Wall, Soil Stability & Foundation)



Wastewater Treatment



Automotive Body Composite



Decorative Materials

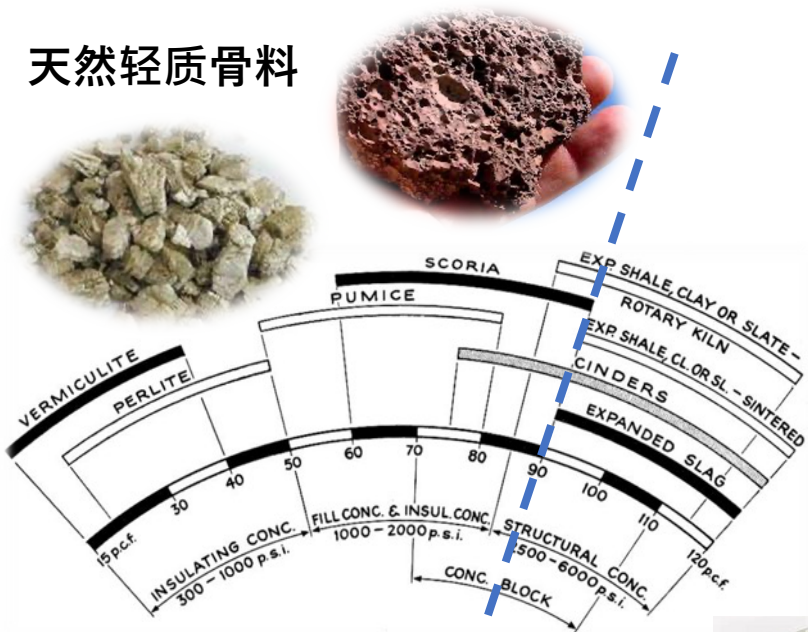


Heat Resistant Paints & Wallpapers

什么是轻骨料？

轻骨料 (LWA) 是具有许多应用的轻质材料的颗粒或粒状骨料。它们既可以从天然来源开采，也可以使用矿物或废料制造。

天然轻质骨料



轻质骨料



Structural LiGrA
Densely packed finer pores



Non-Structural LiGrA
Loosely packed coarser pores

什么是轻质混凝土？

轻质混凝土是通过使用轻骨料取代重骨料来生产的。

1 m³ 正常
重量混凝土

Cement	好 骨料 (沙)
	粗 骨料 (Granite)
Water	

密度 = 2400 Kg/m³

1 m³ 的轻量级
混凝土

Cement	好 骨料 (LWA)
	粗 骨料 (LWA)
Water	

密度 > 800 自 2000 Kg/m³

→ 结构应用

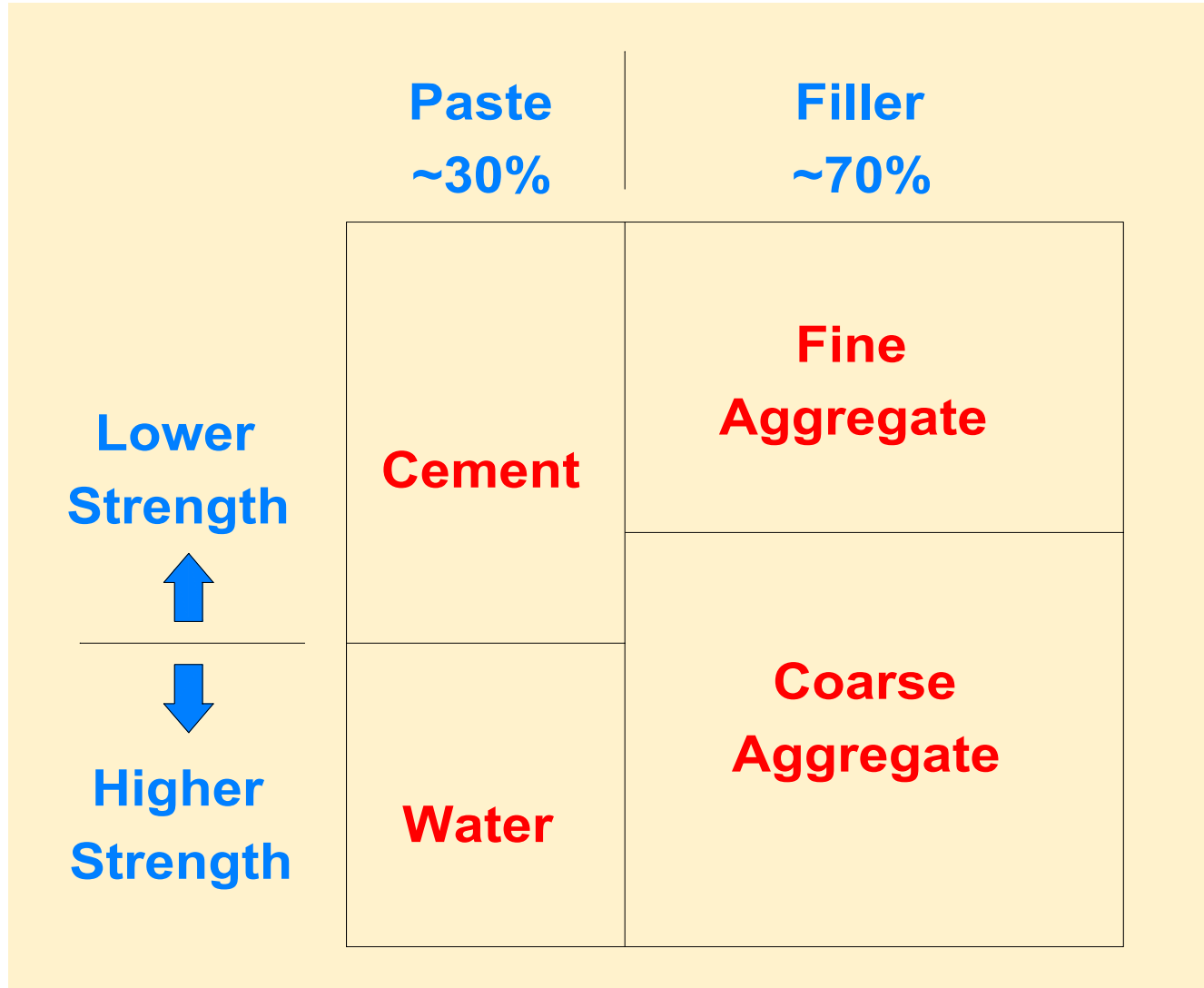
密度 < 800 Kg/m³

→ 非结构性应用

混凝土的历史 - 里程碑

- 1844 ○ 波特兰水泥
- 1849 ○ 钢筋混凝土
- 1917 ○ 轻骨料混凝土
- 1929 ○ 预应力混凝土
- 1960 ○ 纤维增强混凝土
- 1980 ○ 聚羧酸醚

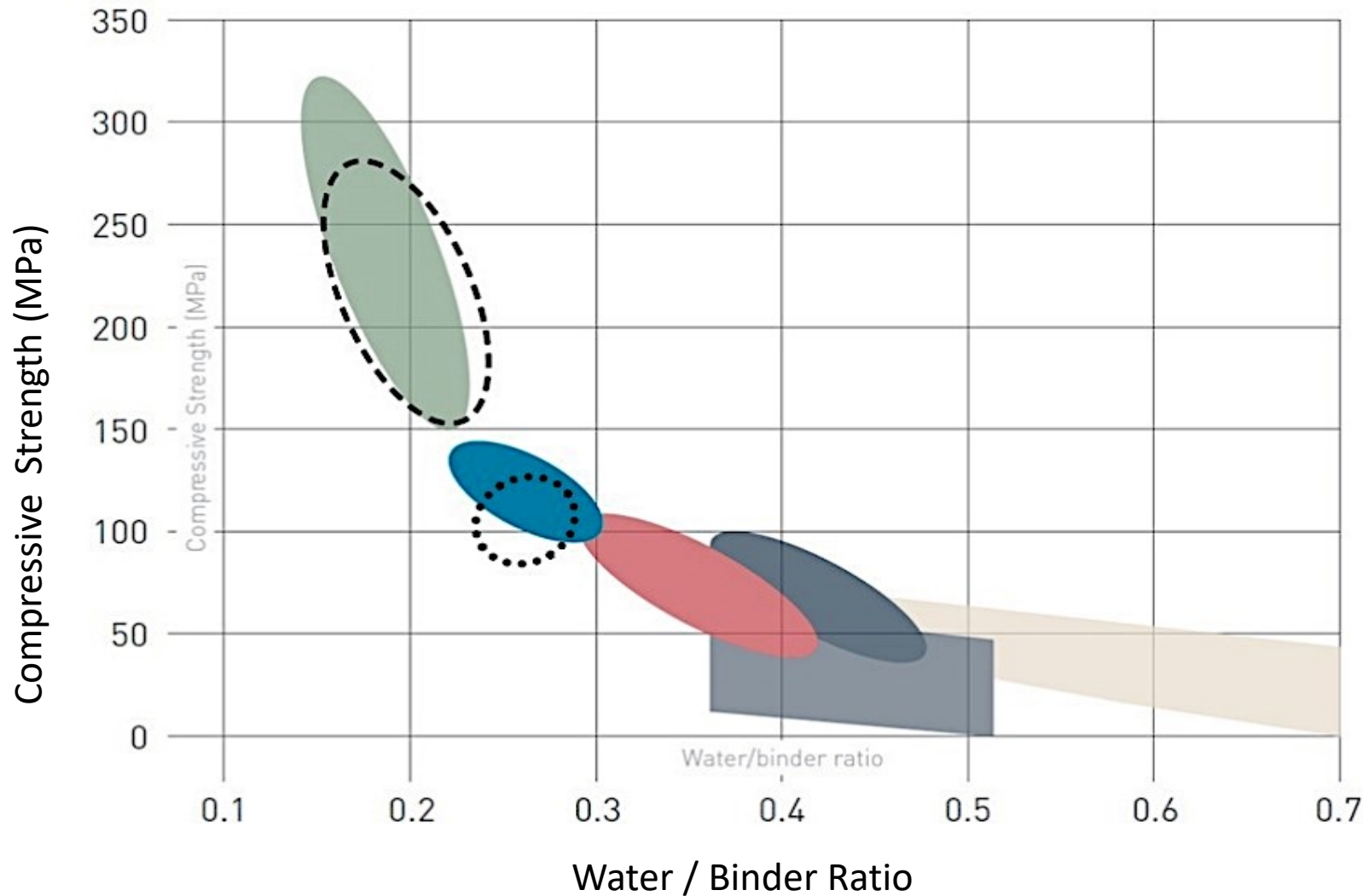
聚羧酸醚在混凝土中的影响



减少混凝土中的水可以提高强度，但会降低和易性。

聚羧酸盐有助于减少混凝土中的水而不降低和易性。

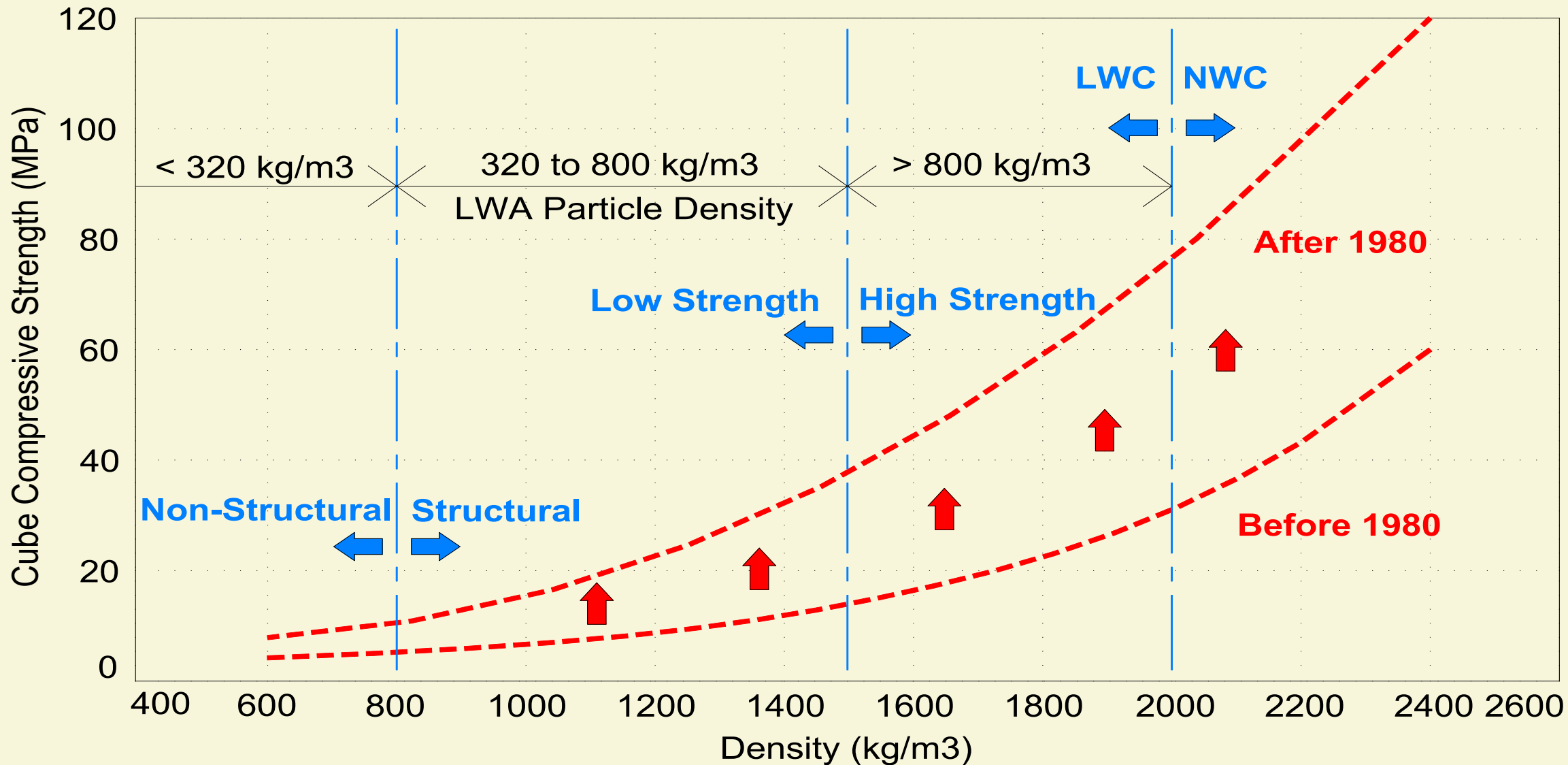
Historical Classification of Concrete

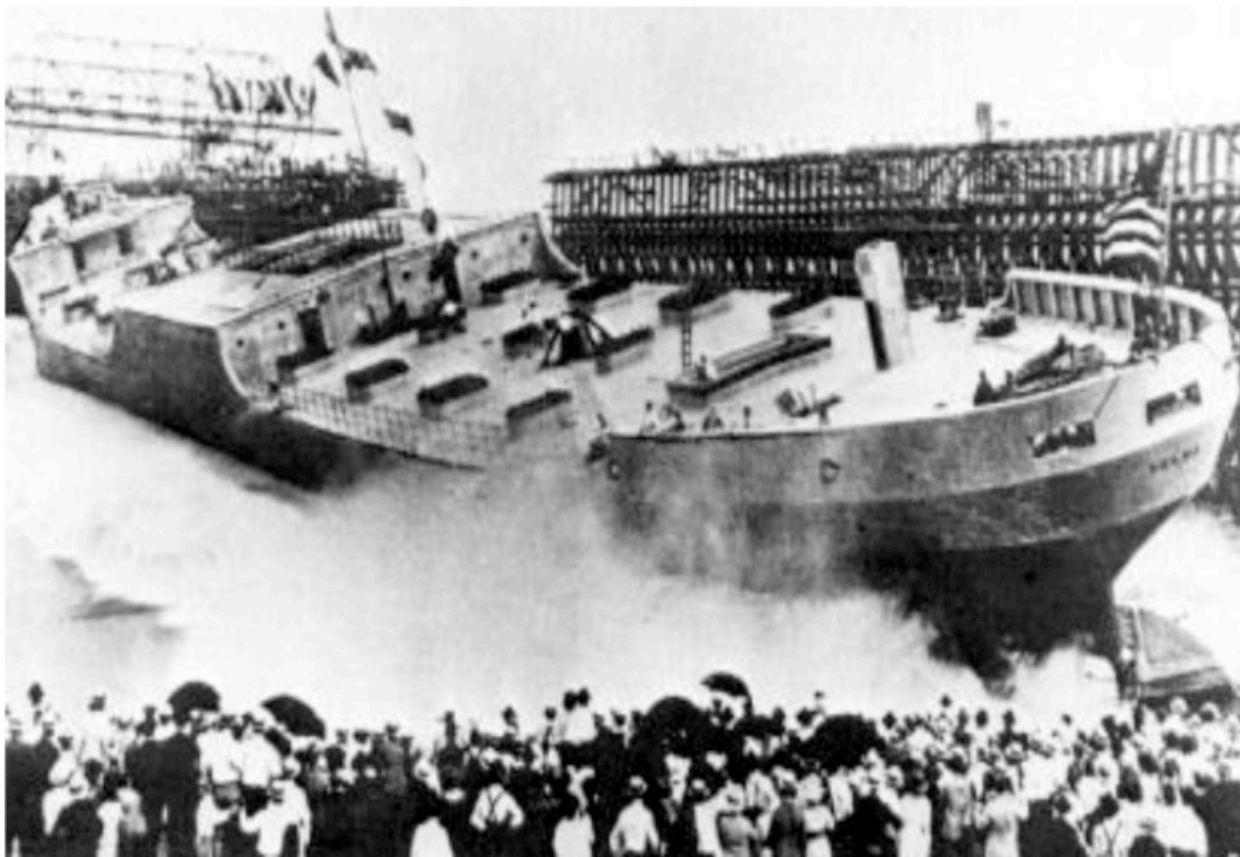


- Ultra High Performance Concrete (UHPC) 2000
- TAKTL A|UHPC™ 2010
- High Strength Concrete (HSC) 1985
- Self Compacting Concrete (SCC) 1995
- Light Weight Concrete
- Normal Concrete
- Ductal Architectural (2012)
- Ductal Structural (1996)

The focus has been on strength. Now the direction has diverted to Density.

1980年后 LWC 实力增强



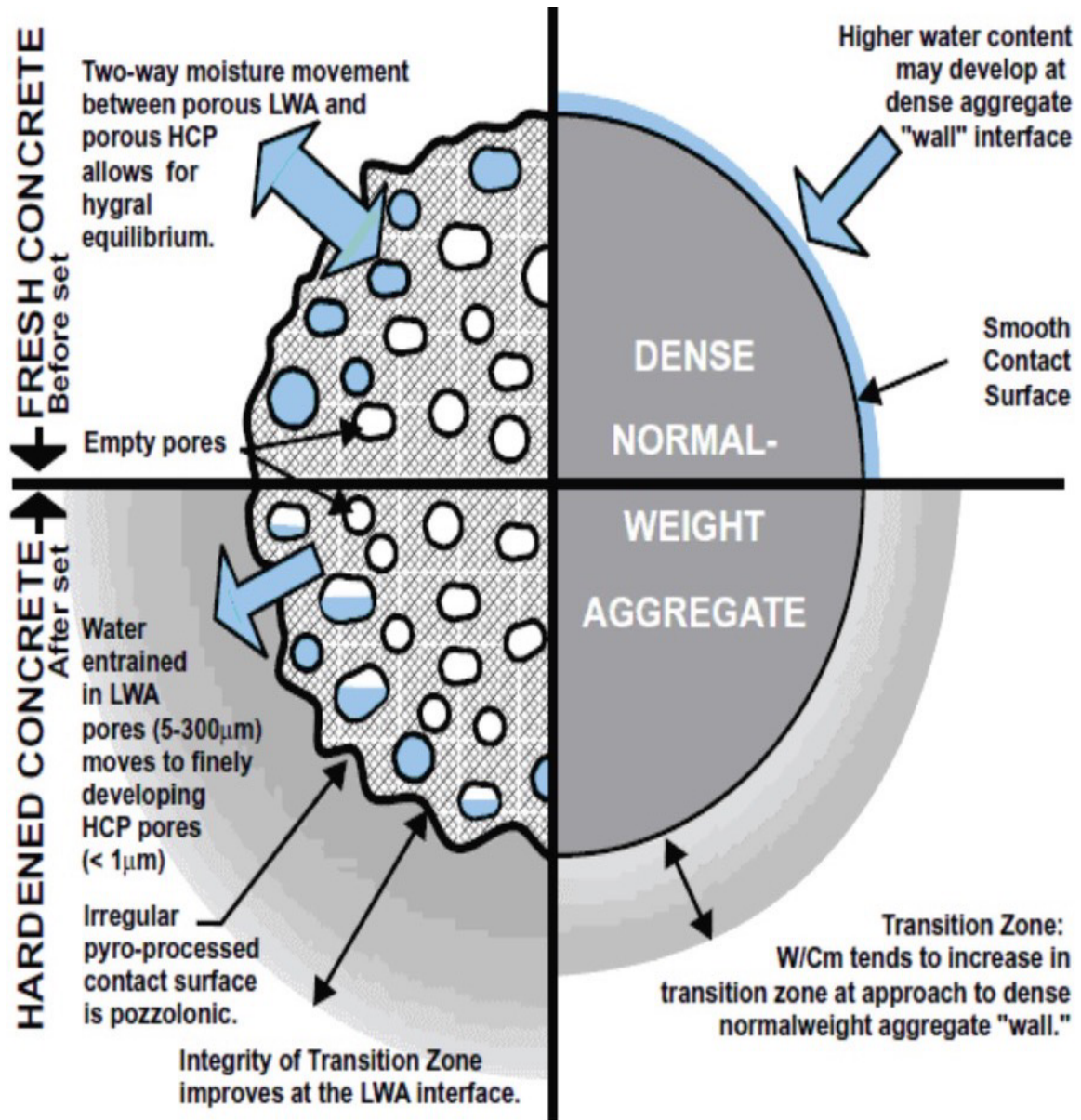


轻骨料最常用于轻骨料混凝土。与正常重量的混凝土相比，轻骨料混凝土已被科学证明具有出色的耐久性和更高的性能，这归因于三个因素：

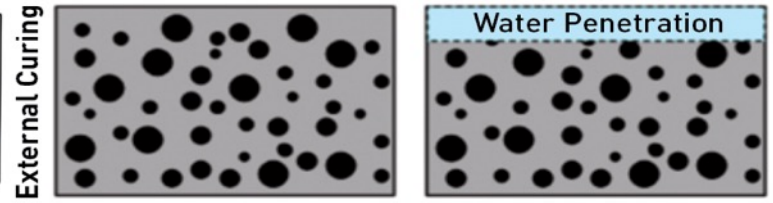
1. 长时间内固化
2. 强骨料-水泥浆界面
3. 骨料和水泥浆的模量相容性

USS SELMA于1919年下水，由抗压强度为26.7 MPa的轻骨料混凝土建造。1980年，当科学家对船进行岩心测试时，发现强度已增加到55.2MPa。对于正常重量的混凝土来说，这种现象是闻所未闻的。

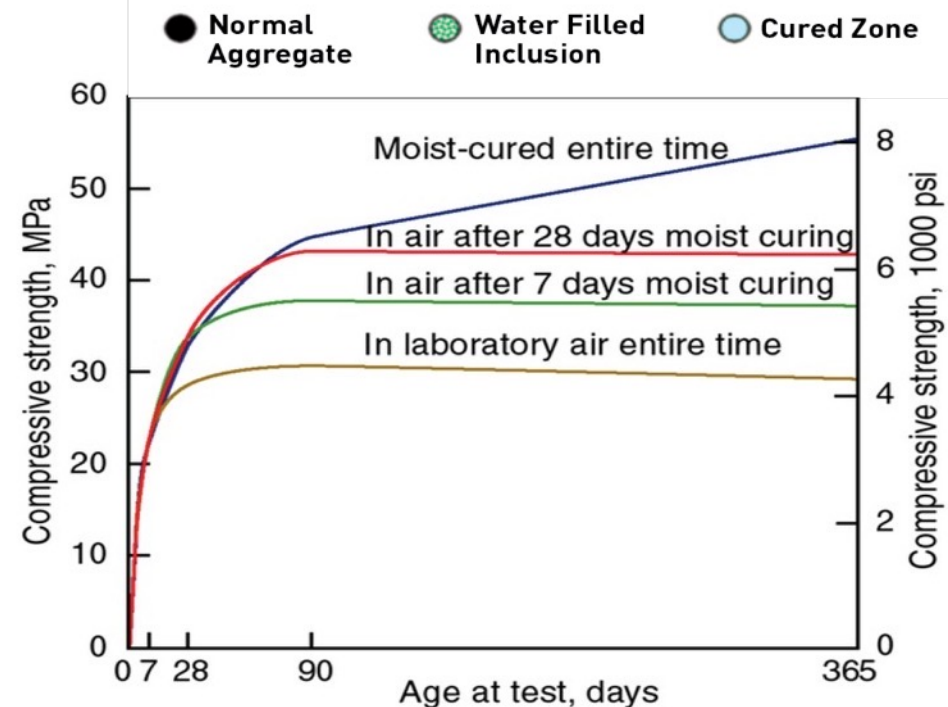
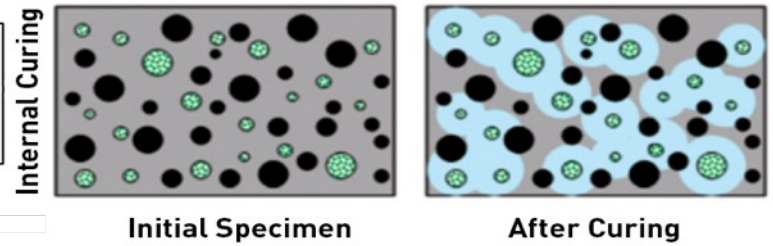
内部固化和强大的界面



NWA
Interface between Hydrating Cement Paste (HCP) and the non-absorbing dense normalweight aggregate "wall"




LWA
Interface between two porous materials [LWA pores and Hydrating Cementitious Paste (HCP)]



轻质混凝土结构



 **The Wellington Stadium**
New Zealand's First Use of High Strength Lightweight Precast Concrete
Leonard G. McSaveney
Golden Bay Cement, Division of Fletcher Concrete & Infrastructure, Ltd., Auckland, New Zealand

STRUCTURAL ENGINEER
Holmes Consulting Group

LIGHTWEIGHT PRODUCER
TXI Pacific Custom Materials, Inc., CA

CONTRACTOR
Fletcher Construction Ltd.

PRECAST SUPPLIER
Stresscrete

OWNER
The Wellington Stadium Development Trust



Exterior of 40,000-seat Wellington Stadium nearing completion



BRITISH STANDARD

Lightweight aggregates —

Part 1: Lightweight aggregates for
concrete, mortar and grout

BS EN
13055-1:2002
*Incorporating
Corrigendum No. 1*

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因素	现状	近期
供应	欧洲 美国 日本	浪费 >> LWA 区域供应商增加
熟悉	BS EN – 2004 / SS EN – 2008 (欧洲规范 2)	
成本	运输成本高 使用开采的矿物	区域供应商 – 降低运输成本 废物利用 – 降低成本

BS EN 1992 - 轻质混凝土折减系数		
混凝土力学性能	密度等级	
	1.6	1.8
抗压强度	1	1
抗张强度	0.85	0.9
剪切强度	0.71	0.75
割线模量	0.56	0.71
蠕变系数	0.56	0.71

为什么轻质混凝土不常用？

Table 11.1: Density classes and corresponding design densities of LWAC according to EN 206-1

Density class	1,0	1,2	1,4	1,6	1,8	2,0	
Density (kg/m ³)	801-1000	1001-1200	1201-1400	1401-1600	1601-1800	1801-2000	
Density (kg/m ³)	Plain concrete	1050	1250	1450	1650	1850	2050
	Reinforced concrete	1150	1350	1550	1750	1950	2150

RC 自重减轻

- Class 1.6 = 30%
- Class 1.8 = 22%

English version	
Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings	
BS EN 1992-1-1:2004 EN 1992-1-1:2004 (E)	
SECTION 11 LIGHTWEIGHT AGGREGATE CONCRETE STRUCTURES	
11.1 General	
(1)P This section provides additional requirements for lightweight aggregate concrete (LWAC). Reference is made to the other Sections (1 to 10 and 12) of this document and the Annexes.	

混凝土强度修正系数

	Normal Weight Concrete	Lightweight Concrete	Remark
Comp Strength	$f_{cd} = \alpha_{cc} f_{ck} / \gamma_c$	$f_{lcd} = \alpha_{lcc} f_{lck} / \gamma_c$	$\alpha_{cc} = \alpha_{lcc} = 0.85$ and $\gamma_c = 1.5$ for both
Tensile Strength	Value given in Eurocode 2, Table 3.1	NWC value multiplied by $\eta_1 = 0.40 + 0.60 \rho / 2000$	$\eta_1 = 0.85$ & 0.89 for Class 1.6 & 1.8, respectively
Shear Strength	$v = 0.6 [1 - f_{ck} / 250]$	$v = 0.5 \eta_1 [1 - f_{ck} / 250]$	Shear Capacity Reduction = 0.71 and 0.75 for Class 1.6 & 1.8, respectively
Secant Modulus	Value given in Eurocode 2, Table 3.1	NWC value multiplied by $\eta_E = (\rho / 2200)^2$	$\eta_E = 0.56$ & 0.71 for Class 1.6 & 1.8, respectively
Creep	Value given in Eurocode 2, Table 3.2	NWC value multiplied by Factor = $\eta_2 (\rho / 2200)^2$ where $\eta_2 = 1.3$ for $f_{lck} \leq LC16/18$ $\eta_2 = 1.0$ for $f_{lck} \geq LC20/22$	Considered in water retaining structure where crack control is particularly important.
Shrinkage	Value given in Eurocode 2, Table 3.2	NWC value multiplied by η_3 where $\eta_3 = 1.5$ for $f_{lck} \leq LC16/18$ $\eta_3 = 1.2$ for $f_{lck} \geq LC20/22$	Considered in water retaining structure where crack control is particularly important.
Non-linear Behaviour		ϵ_{c1} and ϵ_{cu1} should be replaced with ϵ_{lc1} and ϵ_{lcu1} given in Table 11.3.1 in Eurocode 2	No impact when using first order elastic analysis
Concrete Protection	Exposure class given in Table 4.1 and concrete cover given in Table 4.2 in Eurocode 2	No change for exposure class. Concrete cover given in Table 4.2 increased by 5mm	Using LWC does not reduce environmental protection.

减少碳排放

	混凝土与		
	LiGrA	LWA	NWA
更高的耐用性	EC	EC	X
更轻的原材料和混凝土	EC	EC	X
更轻的预制构件	EC	EC	X
更大的预制构件	EC	EC	X
跨度更长的结构	X	X	X
更轻的建筑重量	EC	EC	X
更好的抗震性	X	X	X
更高的热阻	OC	OC	X
替代自然资源	EC	X	X
回收废物	EC	X	X

EC 减少隐含碳排放
 OC. 减少运营碳排放



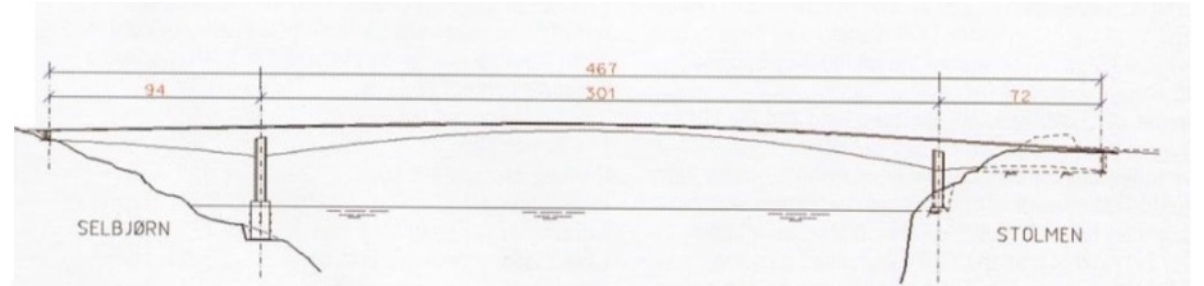
The Bank of America, Charlotte, N.C. built in 1991

选择带有地板系统的轻质混凝土后张拉梁，以最大限度地减少自重并达到所需的 3 小时防火等级

Mix Design	1	2	3
Cement (kg/m ³)	326	385	445
Fly Ash (kg/m ³)	83	83	83
LWA (kg/m ³)	534	534	534
Sand (kg/m ³)	813	763	714
WRA (l/m ³)	0.78	0.90	1.01
HRWRA (l/m ³)	1.56	2.31	2.27
Fresh Concrete Properties			
Initial Slump (mm)	63	51	57
Slump after HRWRA (mm)	130	191	171
Air Content	2.5	2.5	2.3
Fresh Conc Density (kg/m ³)	1887	1890	1890
Compressive Strength			
4 days	29.6	35.2	39.4
7 days	33.6	39.9	44.4
28 days	43.2	47.0	51.4

The Stolma Bridge, Norway

通过调整 301 m 中跨的密度 轻质混凝土，可以将支柱移动到更浅的水域并降低基础成本。



Properties of LWAC		
Mix Design		
Cement CEM-1 52.5	420	kg/m ³
Silica Fume	35	kg/m ³
Natural Sand (dry)	700	kg/m ³
LECA 800 4-12mm	600	kg/m ³
Water	208	kg/m ³
Stabiliser Melstab	12	kg/m ³
Retarder	1	kg/m ³
Leca 800 Dry Bulk Density	825	kg/m ³
Leca 800 Dry Particle Density	1450	kg/m ³
Mean Cube Strength	70.4	MPa
Characteristic Cube Strength	64.1	MPa
Demoulded Density	1931	kg/m ³
Density 28d Cubes	1940	kg/m ³

The Nordhordland Floating and Cable Stayed Bridge in Norway completed in 1993

高强度 LWAC 用于浮桥和 大桥主跨。

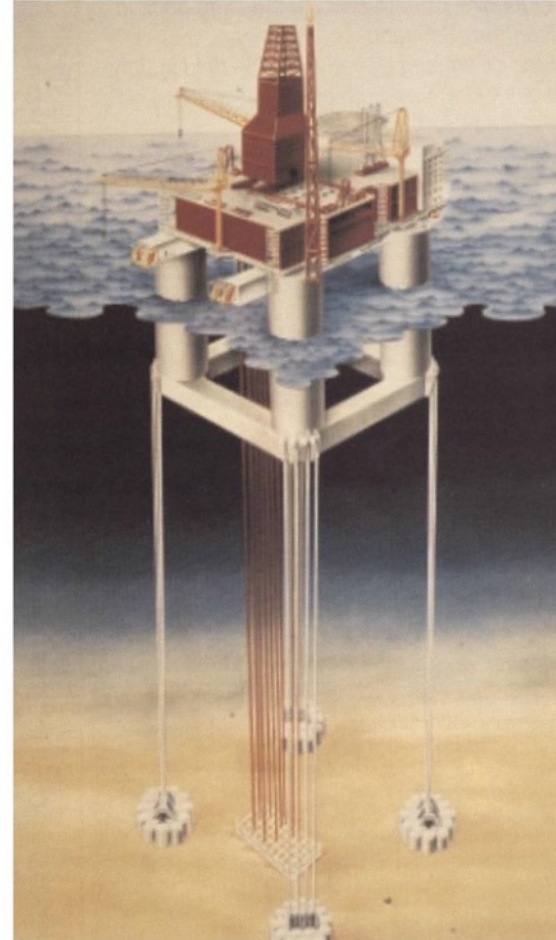


Mix Design for LWAC	LC55 in Pontoon	LC55 in Bridge	
Portland Cement	410	430	kg/m ³
Silica Fumes	33	35	kg/m ³
Sand 0-5 mm	675	630	kg/m ³
Liapor 8, 4-8 mm	270		kg/m ³
Liapor 8, 8-16 mm	325		kg/m ³
LECA 750, 4-8mm		295	kg/m ³
LECA 750, 8-12mm		275	kg/m ³
Water	200	195	kg/m ³
WRA/HRWRA	10 to 12	7	kg/m ³
Demolding Density	1918	1881	kg/m ³
Ave Cube Strength	70.4	69.9	Mpa
Standard Deviation	4.31	2.38	MPa
Bulk Density	800	750	kg/m ³
Particle Density	1440	1300	kg/m ³

张力腿平台所需的高浮力是使用高强度轻质混凝土提供的。

Mix Design of LWAC		
Cement	420	kg/m ³
Silica Fume	20	kg/m ³
Sand	720	kg/m ³
Liapor 8, 4-8 mm (dry weight)	307	kg/m ³
Liapor 8, 8-16 mm (dry weight)	254	kg/m ³
Superplasticizer	6 to 9	kg/m ³
Air-entraining admixture	1 to 3	kg/m ³
Fresh Density	1885	kg/m ³
7 Day Strength	70	Mpa
7 Day Standard Deviation	3.0	
28 Day Strength	79	MPa
28 Day Standard Deviation	3.5	

Heidrun tension leg platform completed in July 1995



轻质混凝土的应用



太阳能电池板HDPE浮动平台



The base of the Ocean Solar plant flexes as waves move underneath it

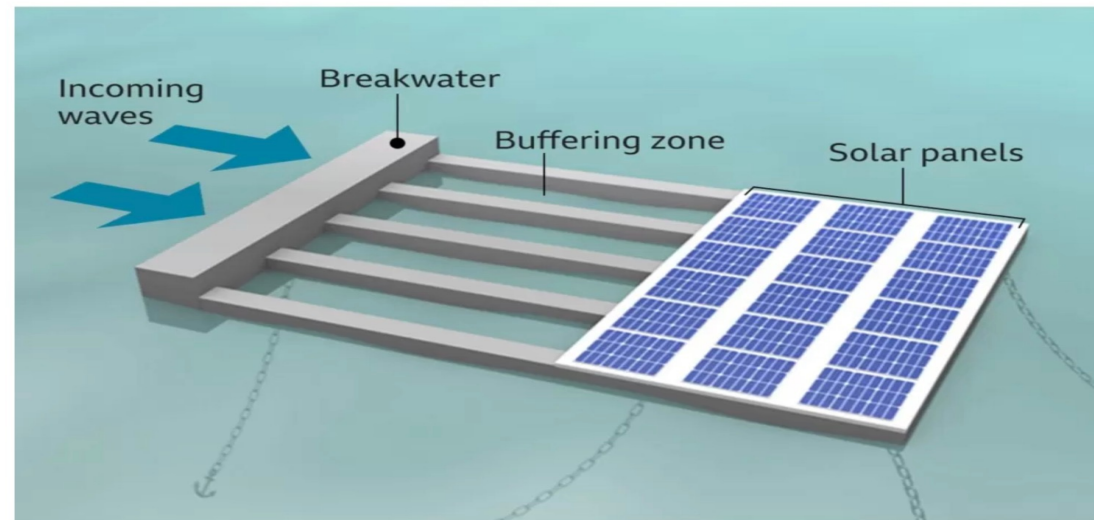


After the outermost row had ripped off the wind-facing edge did not have any ballast anymore to counter uplift from wind. The modules and floaters began to curl-up with the result of an electrical fire.

Image: Solar Power Plant Business / Nikkei Business Publications

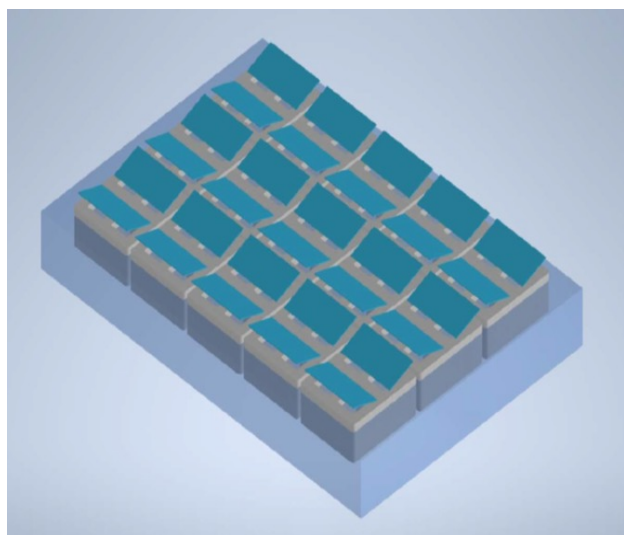


The Solar2Wave system



Source: Cranfield University

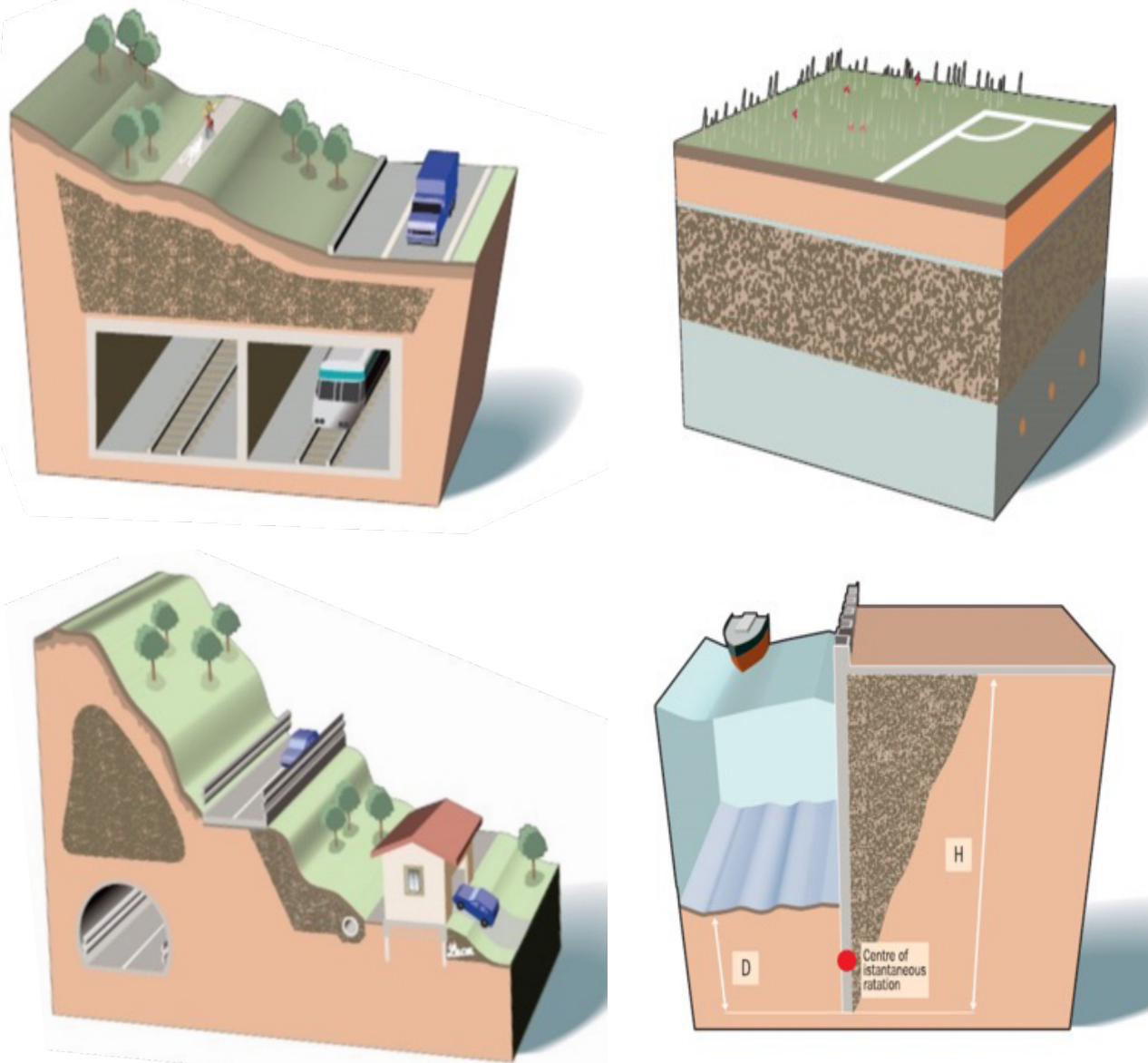
BBC



Performance	HDPE	LiGrA
Load Capacity	✗	✓
Stability	✗	✓
Contaminant to Water	✗	✓
Combustability	✗	✓
Durability	✗	✓

其他应用环保轻骨料

岩土工程应用



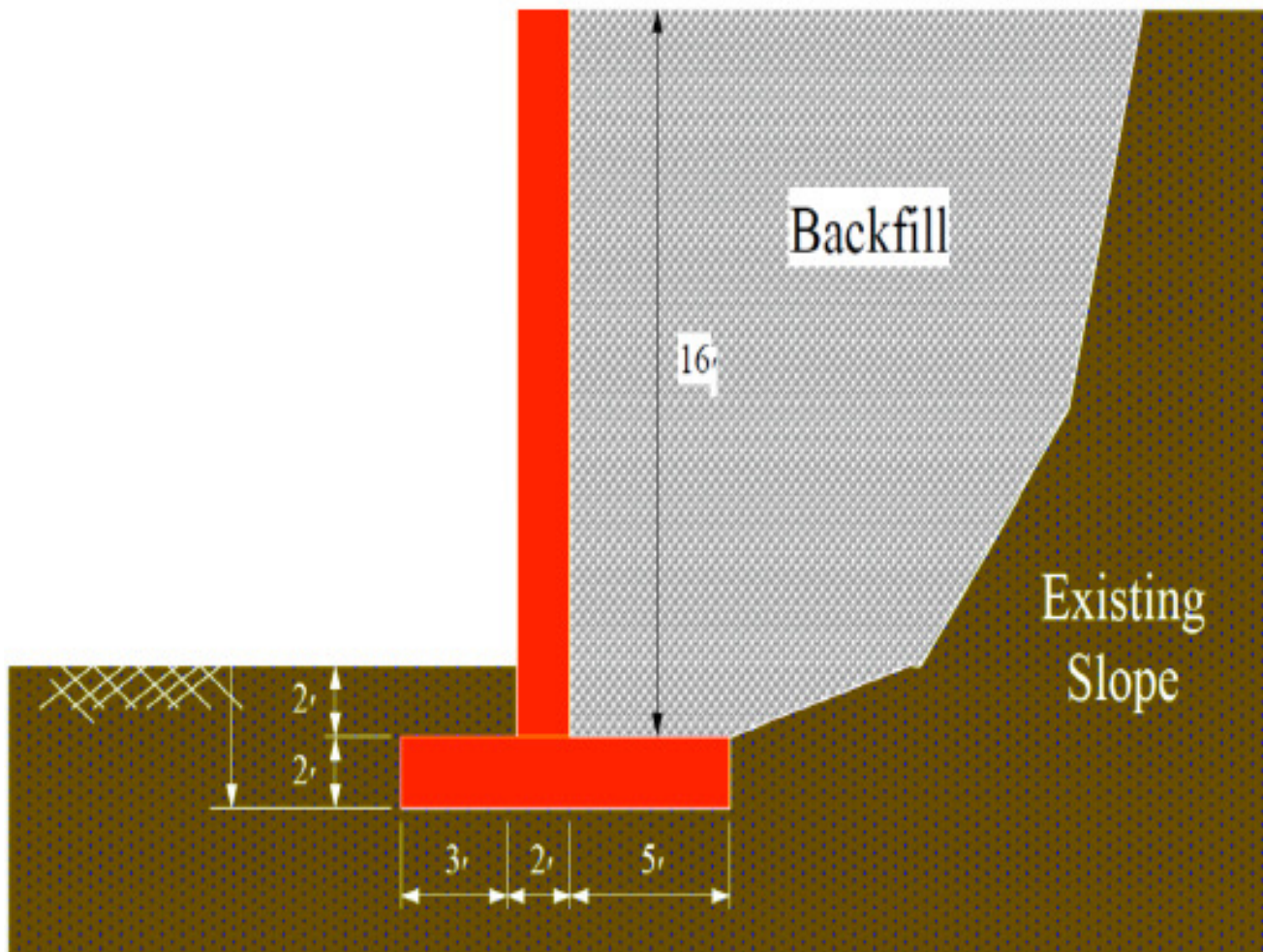
屋顶保温



污水处理厂



挡土墙应用



使用LW回填对墙体设计的影响比较

墙体高度	5m
------	----

	普通土壤	LWA
单件重量	1900 kg/m ³	950 kg/m ³
摩擦角	30 deg	42 deg

安全系数	普通土壤	LWA
推翻	2.8	6.2
滑动	1.6	6.2
承载能力	2.6	6.3

NWC和LWC的比较

	NWC	LWC
机械性能	★	
热阻		★
重量 (更轻)		★
耐久性		★
碳足迹		★
具体价格	★	
节省项目成本		★
可持续性		★

LWC 与 NWC 的优点



Lower building weight → Lesser foundation



Lighter & Larger Precast Component. Longer Span → Construction cost & time saving

LWC 与 NWC 的优点



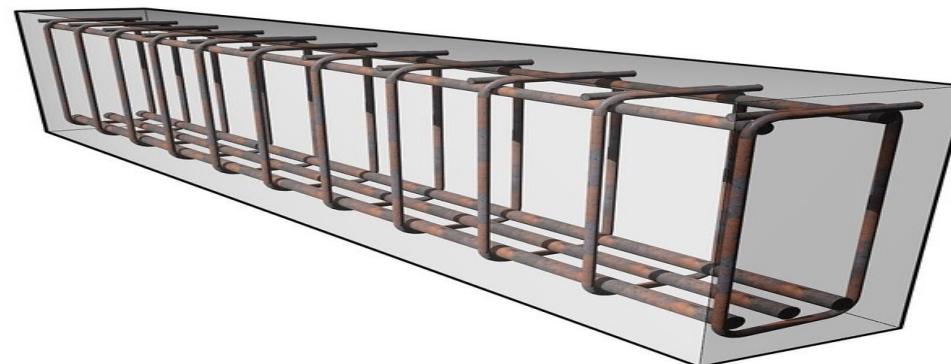
Higher Durability → **Longer life Span**
Lighter Building → **Better earthquake resistance**



Higher Thermal Resistance & Lower Specific Heat Capacity → **Lower aircon consumption & lesser condensation problem**



Lightweight → **Saving in transportation cost**



Lower concrete weight → **Lesser Reinforcement**

- 提高可持续性
- 减少碳排放
- 解决废物处理问题
- 减少天然矿物的开采
- 节省成本



减少采矿活动

回收废物 – 提高可持续性

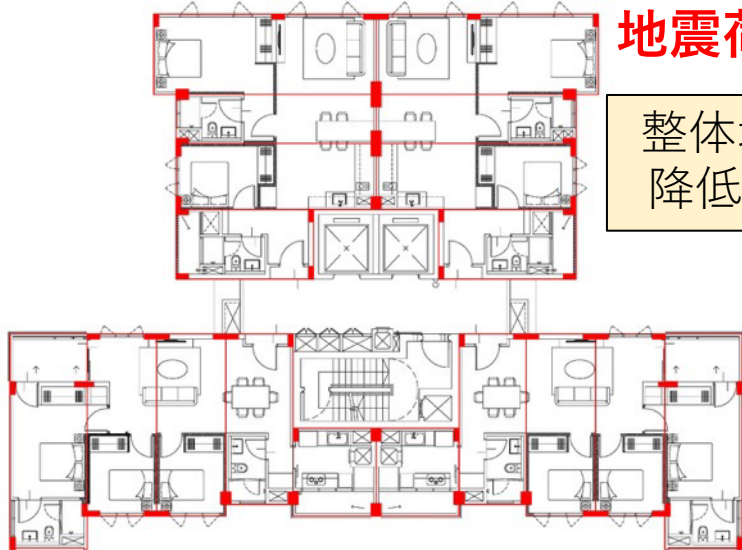


用于绿色建筑的轻质绿色骨料

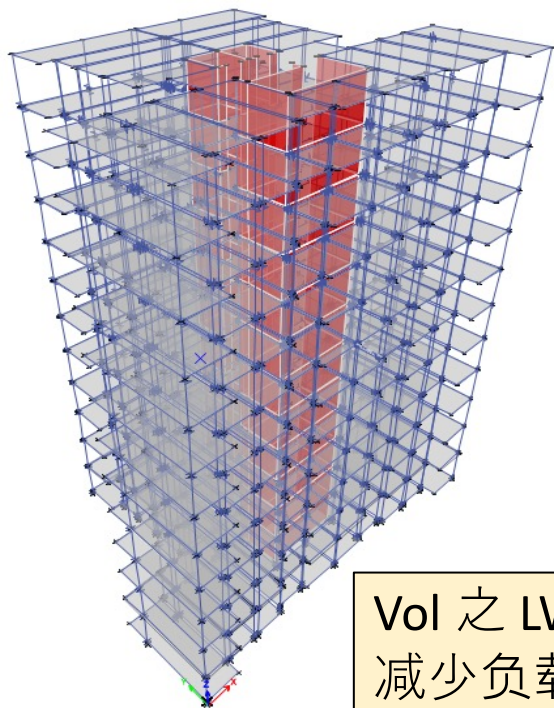
与NWC相比的好处	减少碳排放	节省成本
回收废物	★	★
减少对原始材料的开采	★	★
更高的耐用性	★	★
更轻的原材料和混凝土	★	★
更轻的预制构件	★	★
较大的预制构件	★	★
小基金会	★	★
更长的跨度		★
较少的加固	★	★
更高的抗震性	★	★
更高的热阻	★	★
较低的比热容	★	★
减少冷凝	★	★

地震荷载

整体地震抗力
降低约10%。



TYPICAL MODULE LAYOUT

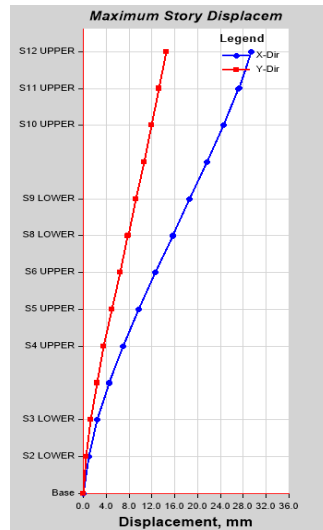


风荷载

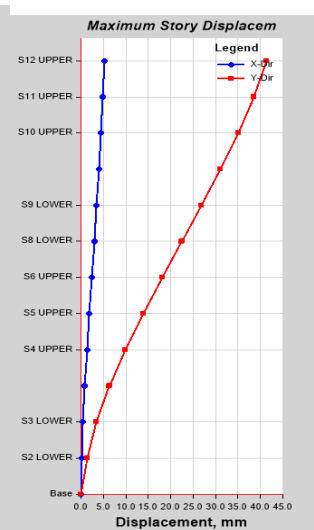
个案研究
密度等级 1.6
合成柱 = 40 MPa

Vol 之 LWC = 1107m³
减少负载 = 830 ton

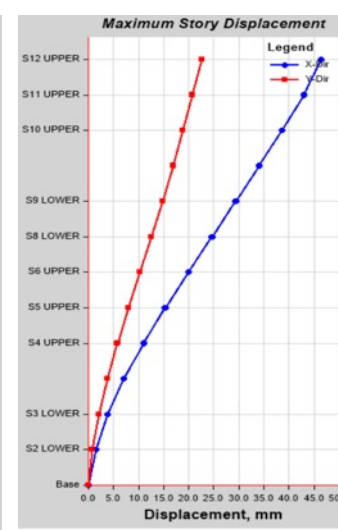
正常重量混凝土



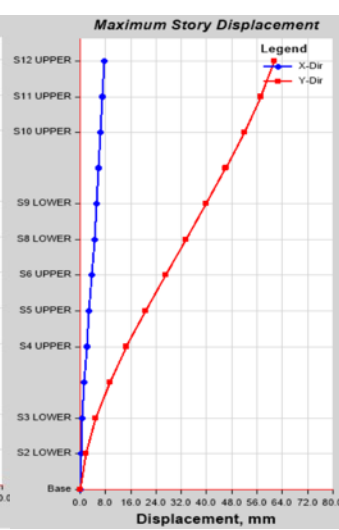
30mm



40mm

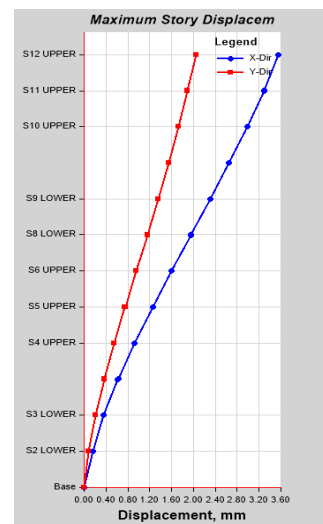


46mm

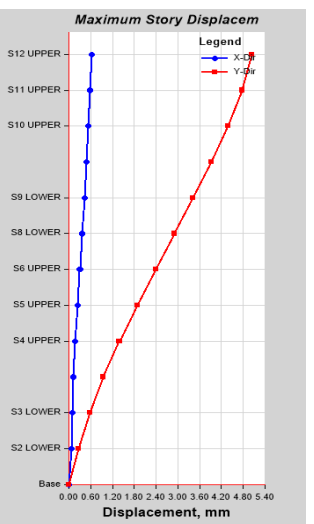


60mm

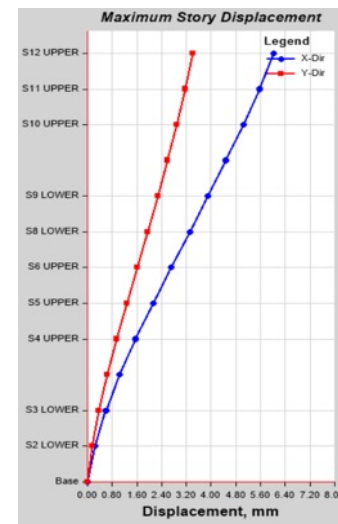
Allowance limit, 189mm (H/200).



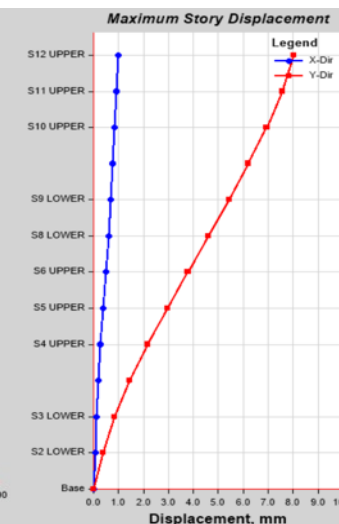
4mm



5mm



6mm



8mm

余量限制, 76毫米 (H/500)。

节省使用轻质混凝土的成本

	卷 m ³	成本 SGD	
		NWA	LWA
水泥	0.145		
水	0.155		
沙	0.3		
骨料	0.4	31.8	216

预计建筑成本 SGD

$$= 8,000 \text{ Sqft} \times 12 \text{ 层} \times \text{SGD } 350$$

$$= 33,600,000$$

SGD 的额外费用

$$= 1107 \times (216 - 31.8)$$

$$= 203,909 \text{ (0.6\% 的建设成本)}$$

这些好处

1. 由于减少了830吨的自荷载，因此基础成本
2. 由于预制构件较轻，运输成本更低
3. 更高的耐用性带来的维护成本
4. 高隔热性导致的能源成本
5. 更大的空间，更少的列
6. 更轻的死载荷，更少的钢筋
7. 减少隐含和运营碳排放

对

LiGrA 的成本



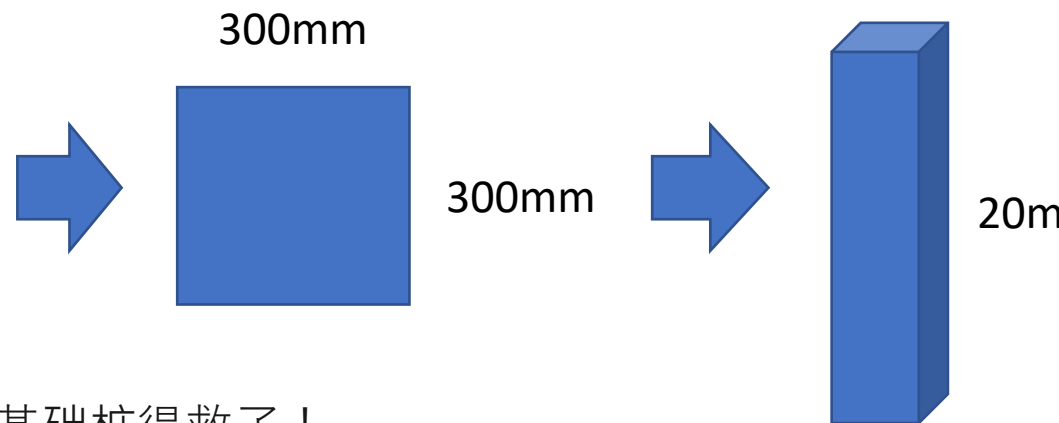
SGD 203,909

节省使用轻质混凝土的成本

1. 减少自荷载导致地基成本

假设使用的基础是 300 x 300mm 的平方桩：

- 允许桩容量为每米90吨
- 应用的安全系数 (FOS) 为 2
- 打桩深度为20米



节省的桩数：
$$\frac{\text{Reduction of applied load} \times \text{Dead Load factor}}{\left(\frac{\text{Allowable pile capacity}}{\text{FOS}}\right)} = 26 \text{ 基础桩得救了！}$$

参数 / 性能	成本 SGD/单位	Total Cost Savings SGD
打桩的供应和安装	61.80	32,136.00
打桩成本和 供应封盖板	53.00	1,378.00
低碳钢的安装 桩鞋	45.00	1,170.00
基金会总储蓄		34,684.00

成本计算基于建屋发展局建筑工程、土木工程和电气的标准费率表

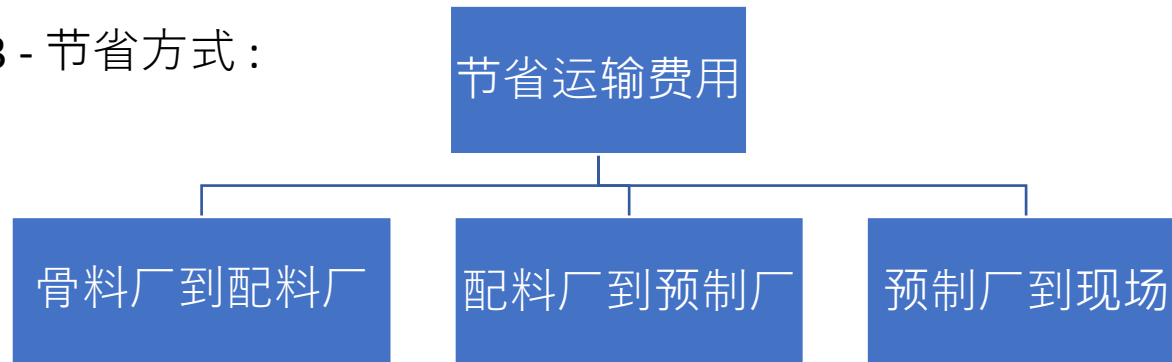
节省使用轻质混凝土的成本

2. 通过更轻的材料和预制件节省运输成本

假设：

- 运输费用约为SGD 271.73
- 卡车容量为25吨

3 - 节省方式：



Granite



LiGrA



减少约 $\frac{1}{8}$ to $\frac{1}{10}$ 在重量

减少 830 吨骨料的负载，所需的卡车数量：

$$\text{No. of lorry required} = \frac{\text{Reduction in load (aggregates)}}{\text{Lorry capacity (tones)}} = 34 \text{ lorries saved!}$$

参数 / 性能//////	成本 SGD/单位
运输成本	271.73/趟次
哈哈所需卡车数量	34
节省运输费用	27,716.46

除了节省资金外，它还将减少卡车引起的运营碳排放。

节省使用轻质混凝土的成本

3. 更轻的自载, 更少的钢筋

假设:

- 混凝土中钢筋的标准百分比约为3%
- 假设6m跨度的T型梁作为相关比较的案例研究

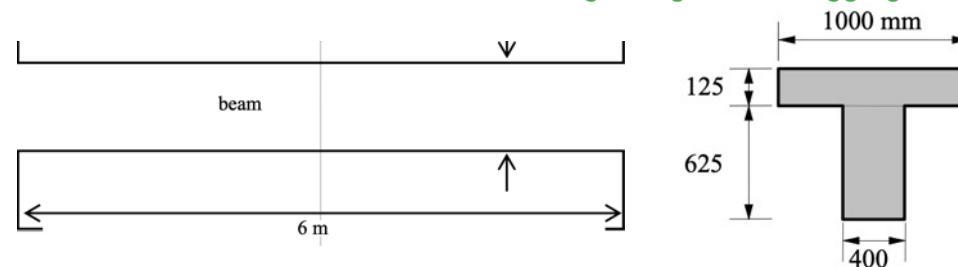
工作负荷:

NWC		LWC	
静载	活荷载	静载	活荷载
40 kN	30 kN	27.83 kN	30 kN

6米跨度梁的成本核算:

钢筋总质量	大量的 Kg	成本/Kg	成本 SGD/Kg
NWC	200.46	2.60	521.20
LWC	179.36	2.60	466.33
Reduction in cost SGD			38.40

假设箍筋设计减少了总钢筋的 30% 左右



使用直径12mm的钢筋设计:

钢筋尺寸	位置	NWC	LWC
N12	I-结束引导	10	9
	中引导	18	16
	I-结束引导	10	9

使用 LWA, 钢筋的百分比减少了大约 10.53%。
该百分比可用于计算案例研究的成本节约。

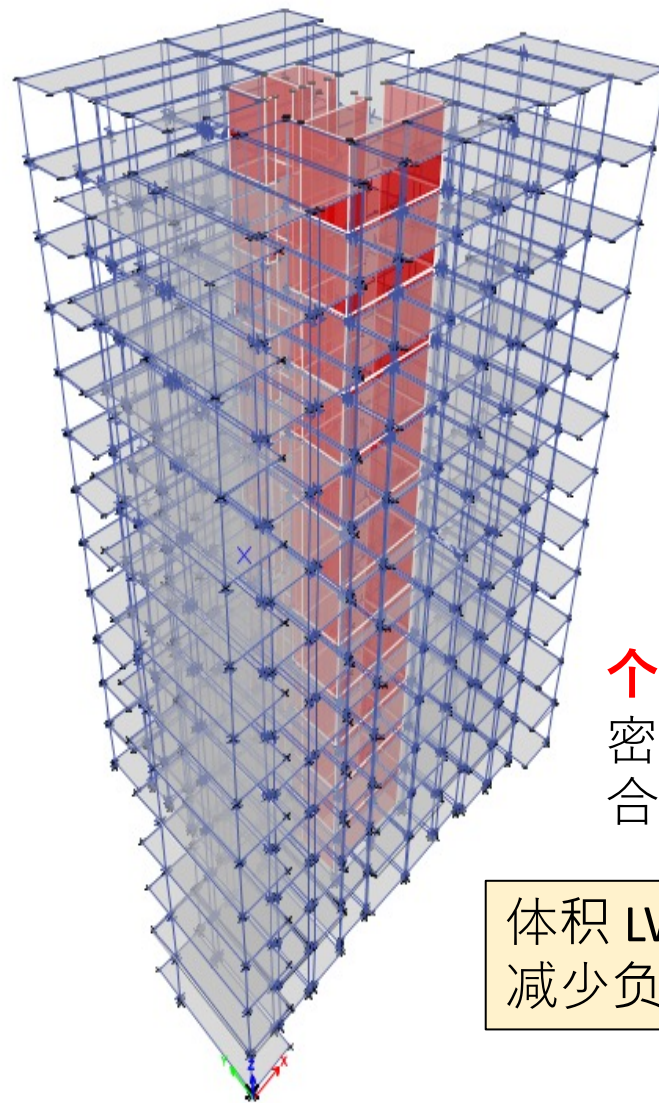
节省使用轻质混凝土的成本

假设：

- 钢筋混凝土的经验法则钢数量 = 3%
- 钢的密度为 7, 850 kg/m³

参数	质量 (音调)	成本 SGD 2.60 / kg
NWC	260.70	677,820
LWC	233.26	606,470.53
储蓄	27.44	71,349.47

根据本案例研究，通过使用 LiGrA，可以节省 71,349.47 新元。结构的自重减少了建筑物的恒载。由于恒载较小，钢筋混凝土需要较少的钢筋。



个案研究

密度等级 1.6

合成柱 = 40 MPa

体积 LWC = 1107m³
减少负载 = 830 ton

4. 高隔热性导致的能源成本

假设：

- 房间空调的节能是通过节能比（EER）来衡量的
- 家庭电费为每千瓦时0.30新元 – 能源市场管理局（2022）
- 空调单元“大金MKS65TVMG”频道4室内机（IDU）为4室公寓（组屋）
- 案例研究建筑面积为8000 Sq Ft 或 743.22 Sqm

参数	NWC	LWC
混凝土密度 (Kg/m ³)	2350	1600
材料电导率, k (W/m/K)	1.16	0.54

减少 53.45%
正常重量混凝土 (NWC)

为 AC 单位与 $21,200 \frac{\text{Btu}}{\text{hr}}$ = 冷却组屋的 4 个房间单位 (85-93 Sqm)

参数	4- 客房公寓 (参考)	Case Study PPVC
建筑面积 (平方米)	93	743.22
空调装置的能源使用量 (Btu/hr)	21,200	169,422

这个数字代表AC的容量。
了解容量，我们如何找到
功率 W 被交流电吸收？

5. 高隔热的能源成本

假设能效比(EER) 之 10:

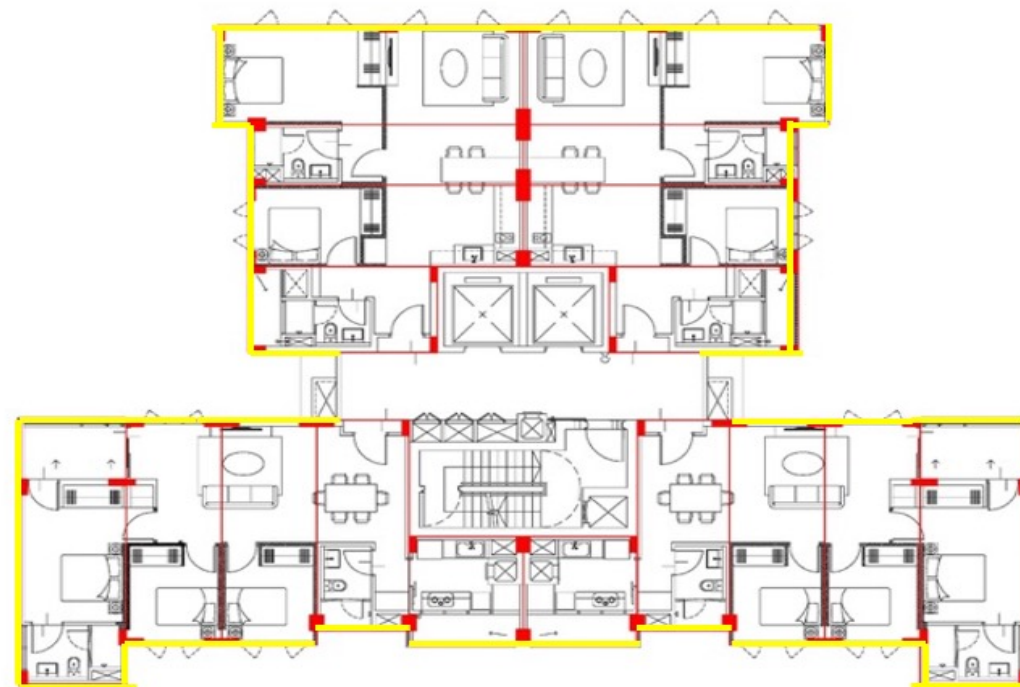
$$EER = \frac{\text{Output cooling energy (BTu)}}{\text{Input electrical energy (Whr)}}$$

$$\text{Input electrical energy} = 16942.2 \text{ W}$$

LWC的输入电能 (瓦特)

$$(100-53.45)\% \times 16942.2 \text{ Btu/hr} = 7886.60 \text{ W}$$

参数 / 性能	NWC	LWC
功耗 W	16,942.2	7886.60
消耗的能源 kWh/日	406.61	189.28
1kWh 成本 SGD	0.30	0.30
能源 成本/年 SGD	43,914.18	20,442.06
节约能源成本 SGD/年	23,472.11	
节约能源成本 30 年	234,721.10	



典型模块布局

使用LiGrA，可以降低交流机组的能耗。根据此案例研究，10年节省的总金额为234,721.1新元。这一发现得到了具有高隔热性的LiGrA特性的支持。

6. 更大的空间， 更少的支撑柱子

基于钢筋的节省， 使用 轻骨料LWA：

- 建筑自重将减少
- 从结构上从梁转移荷载所需的较少柱子
- 支撑柱数量较少



正常重量聚合



轻质骨料

Comparison	NWC	LWC
柱子之间的间距	↓	↑
设计效率	✘	✔
成本优化	✘	✔

7. 更高的耐用性带来的维护成本

使用LiGrA如何帮助降低维护和维修成本？



损坏方法	溶液	成本 SGD
渗水	外墙漏水修复 (PU灌浆)	400-800 (Exc. GST)/m2 裂缝数
冻融损坏	混凝土密封剂	1.25 to 1.75/ Sqft
墙上的真菌由于冷凝而出现	霉菌修复	3500/服务

通过使用LiGrA，我们可以降低维护率，从而降低维护结构的成本。

总节省与总额外费用

储蓄	节省LWC	减少系数	节省成本 新元
建设	基础成本	桩的使用	34,684.00
	运输成本	卡车	27,716.46
	加固成本	钢筋	71,349.47
操作	能源成本	交流机组电力	234,721.10
	总成本节约(新加坡元)		368,471.03



总额外费用为SGD 203, 909.40

总成本节约：
 从维护成本中排除费用
 减少隐含和运营碳排放
 超过使用LiGrA时要花费的额外费用。

使用 LiGrA 减少碳排放

含碳 - The ICE Database	kg CO2e / kg
LiGrA	0.278
Granite Agg	0.00438
LECA	0.393

Additional CO2e due to use of LiGrA = 123.1 ton CO2e
 Additional CO2e due to use of LECA = 168.9 ton CO2e

减少碳排放	ton CO2e
废玻璃从焚烧中转移	436.6
节省交通费	9.7
较少的强化	145.3
基础较少	28.0
全部的	619.6

运营碳减排	ton CO2e
空调整节能 (年)	38.6
更长的使用寿命	
更少的维护	
全部的	38.6
30 年来, 减少 = 1,158 ton CO2e	

来源: (1) ICE DB V3.0 (Embodied Carbon of Materials), (2) NEA 5th Biennial Report 2022,
 (3) IPCC Transport tool Version 2.6, (4) IGES List of Grid Emission Factors 2021, (5) Korea LCI Database

Save Our Just One Earth





The Art of Lightweight Technology

Contact Us :



E-Catalogue :



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