

2020
International
Smart Cities e-Forum
智慧城市國際線上論壇



3D Printing Application for Smart Construction

Yi-Min Huang, Ph.D.

Assistant Professor

Dept. Civil Engineering, Feng Chia University

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Outline

- Introduction
- Practices



Yi-Min Huang, Ph.D.

Assistant Professor, Dept. Civil Engineering, FCU

Specialties: Geotechnical Engineering, Earthquake Engineering, Soil Liquefaction, Numerical Analysis, Debris Flow, Natural Hazard and Monitoring, GIS, Smart City and Smart Constuction

Contact: ninerh@mail.fcu.edu.tw



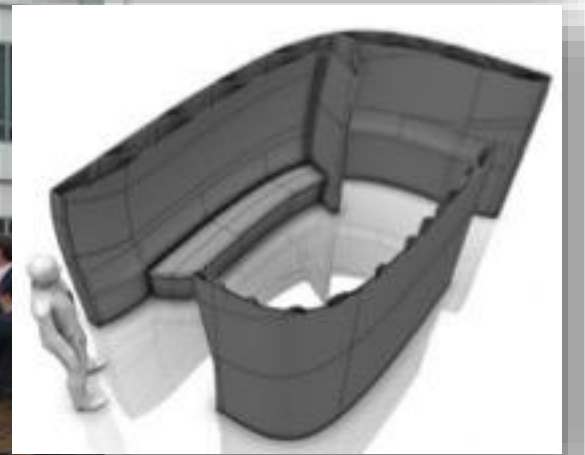
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https://www.youtube.com/watch?v=GUdnrtnjT5Q&feature=emb_logo





Practical Topics

3D Printing

Smart Construction:

Application of **3D Printing**
for **Construction** and Civil
Engineering



Robotic Solutions | AIoT | Automation

WET LAB

INNOVATIVE MATERIALS AND ENGINEERING R&D CENTER

- 3D concrete printing (NEW material)
- Prefab housing (Module & Customized)
- Drone application in Structure Health monitoring, Surveying, & Construction (UAV & AI)
- Sensors for structure health monitoring (Micro Mechanics)
- Automatic construction using robotics (Robotics & Automation)
- BIM/3D-GIS in Construction Safety Planning



**Robotic Control &
Construction**

What to do?

- Smart Construction
 - AI and Robotics → innovative way to apply for constructions (buildings) and civil engineering practices (roads, bridges, ...)
 - New material
 - New machine
 - New procedures
 - Improve the traditional construction works
 - Automation
 - UAV and AI → smart field monitoring
 - Sensors and new material → environment friendly
 - Architectural Medicine
 - Customized Design and Building



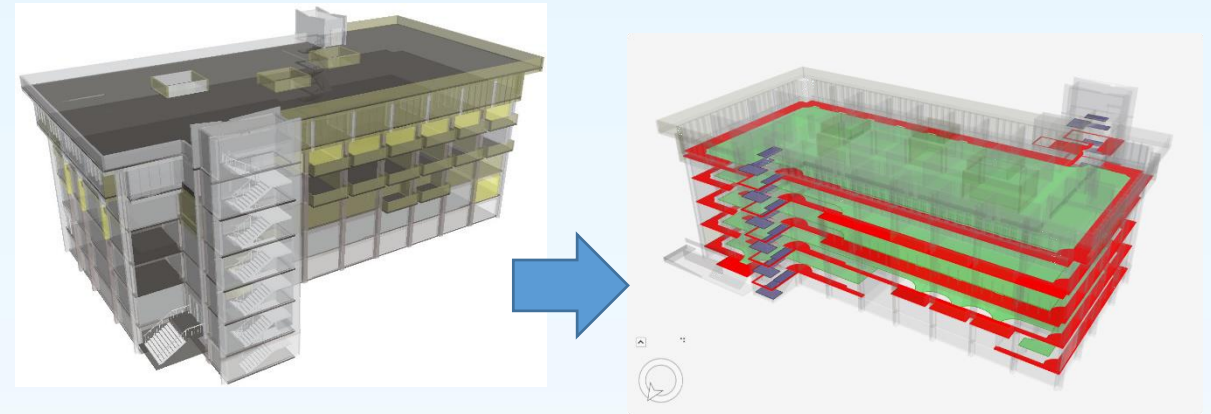
Why?

- Lack of labors in the future. → Use less workers to finish more jobs.
- New material and new technology of AI, robotics, UAV, ...etc. → Higher efficiency and safer working environment.
- Smart management and environmental-friendly low-impact constructions → sustainable development and “happy” civil engineering.



How?

- New Material
 - Improved concrete
 - Innovative material
- Large-scale 3D Printing
 - Precast methods
 - Prefabricated elements
- Construction Aids and Key Elements
 - Robotic Assisted System
 - Automated Field Monitoring System
- Sensors
 - Temporary monitoring
 - Permanent build-in sensors



BIM Model



Deploying iBeacon in site & mobile apps for real-time hazard warning

Precast

vs.

Cast-in-Place







https://www.youtube.com/watch?time_continue=84&v=9sKt-QD4fzE&feature=emb_logo

World's first 3D-printed bridge opens to cyclists in Netherlands

<https://www.theguardian.com/technology/2017/oct/18/world-first-3d-printed-bridge-cyclists-netherlands>





NTU hostel to be built Lego-style

<https://www.asiaone.com/singapore/ntu-hostel-be-built-lego-style?page=0%2C1>





3D Printing in Construction Industry ⇒ **Precast + Cast-in-Place**



We want...

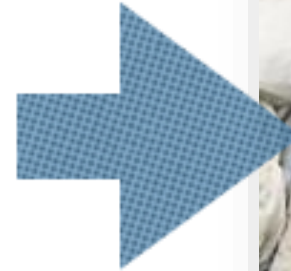


However,...

Small steps lead to big changes.



Practical Projects



Software

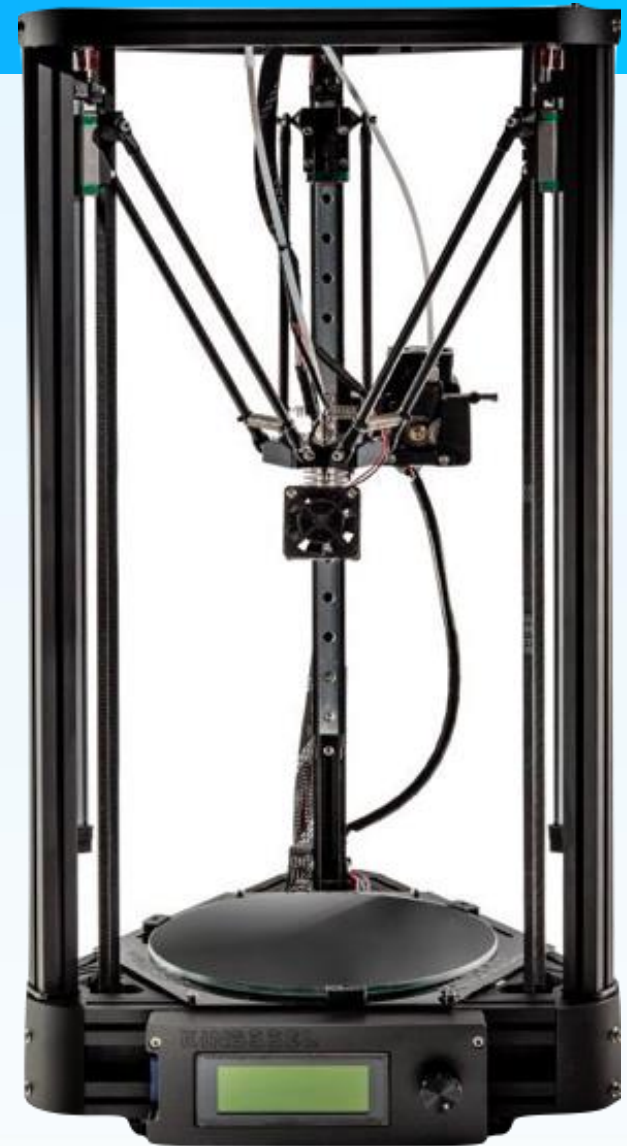
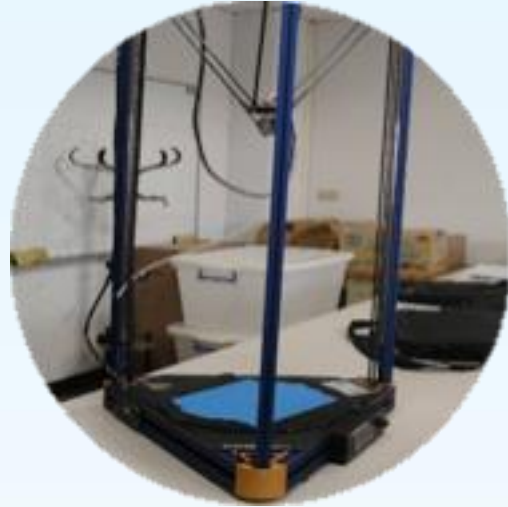


SketchUp
Model building



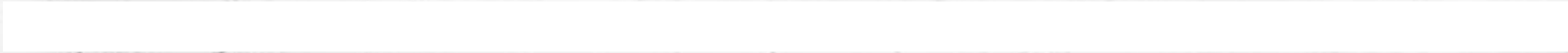
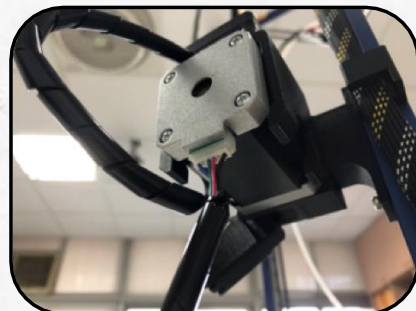
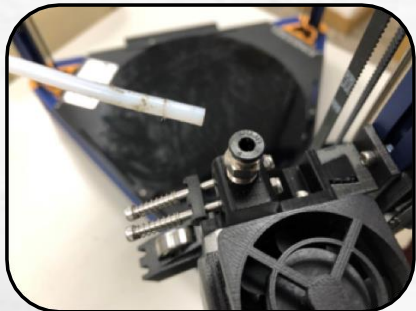
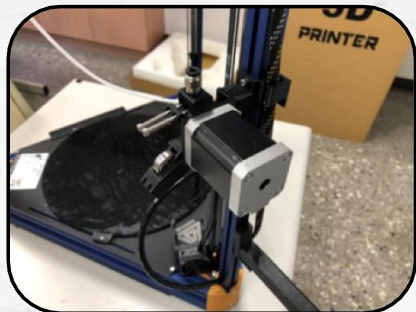
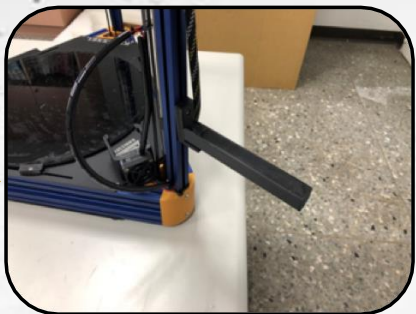
Ultimaker Cura
3D model to 3D printing

Hardware



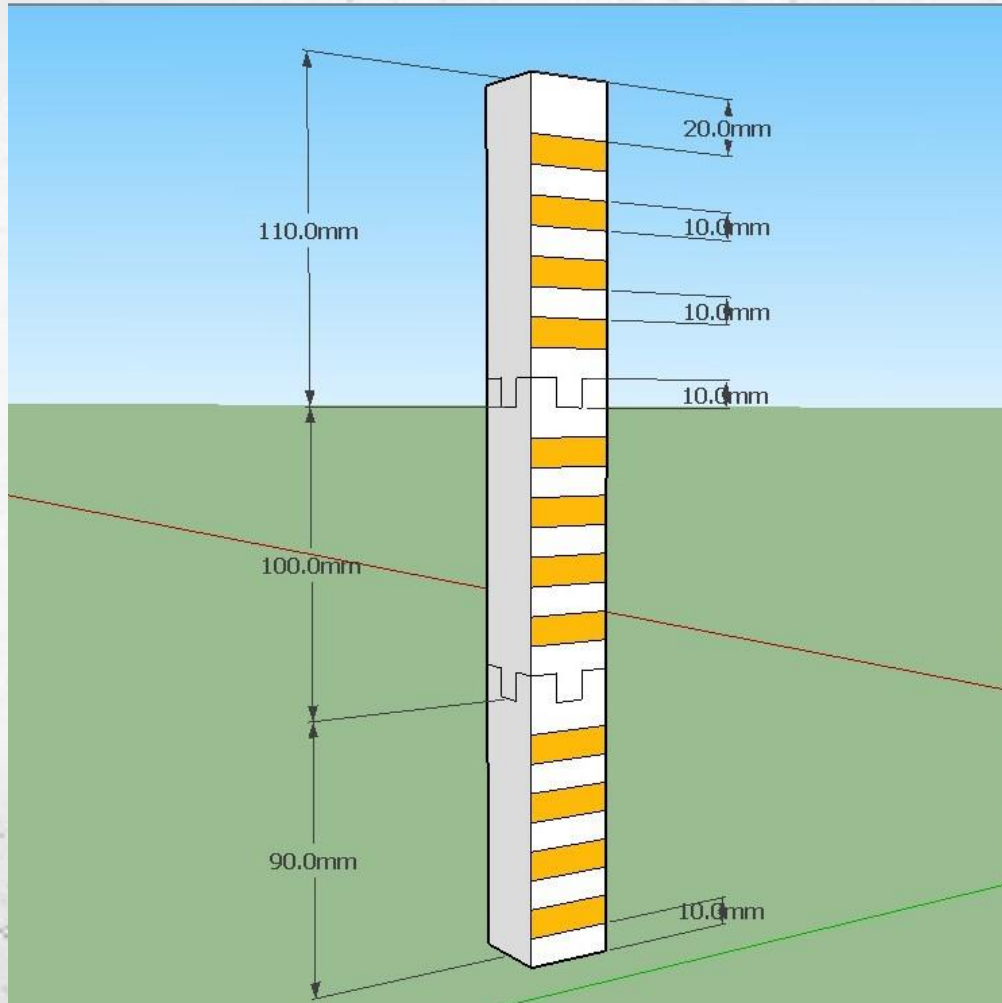
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Operation



3

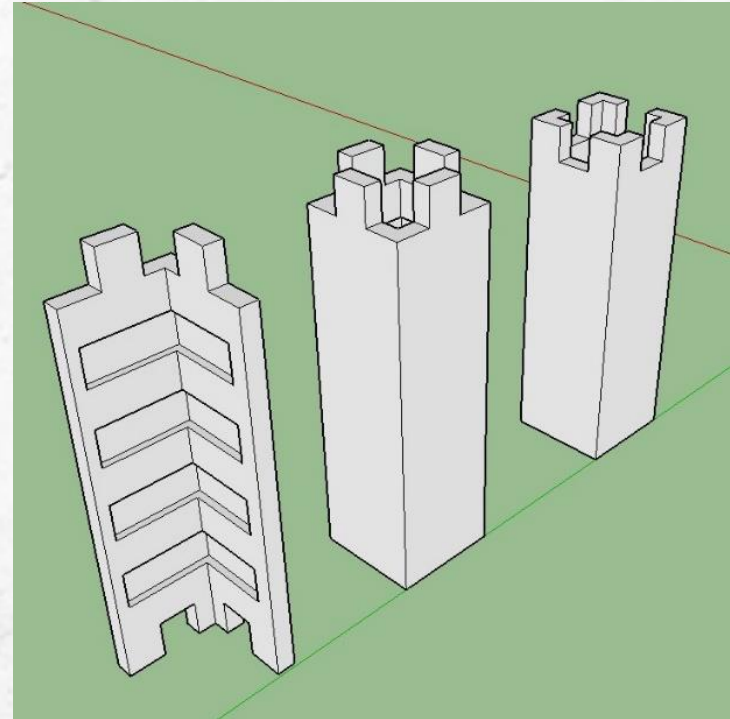
Model Design - Column



+ 小柱

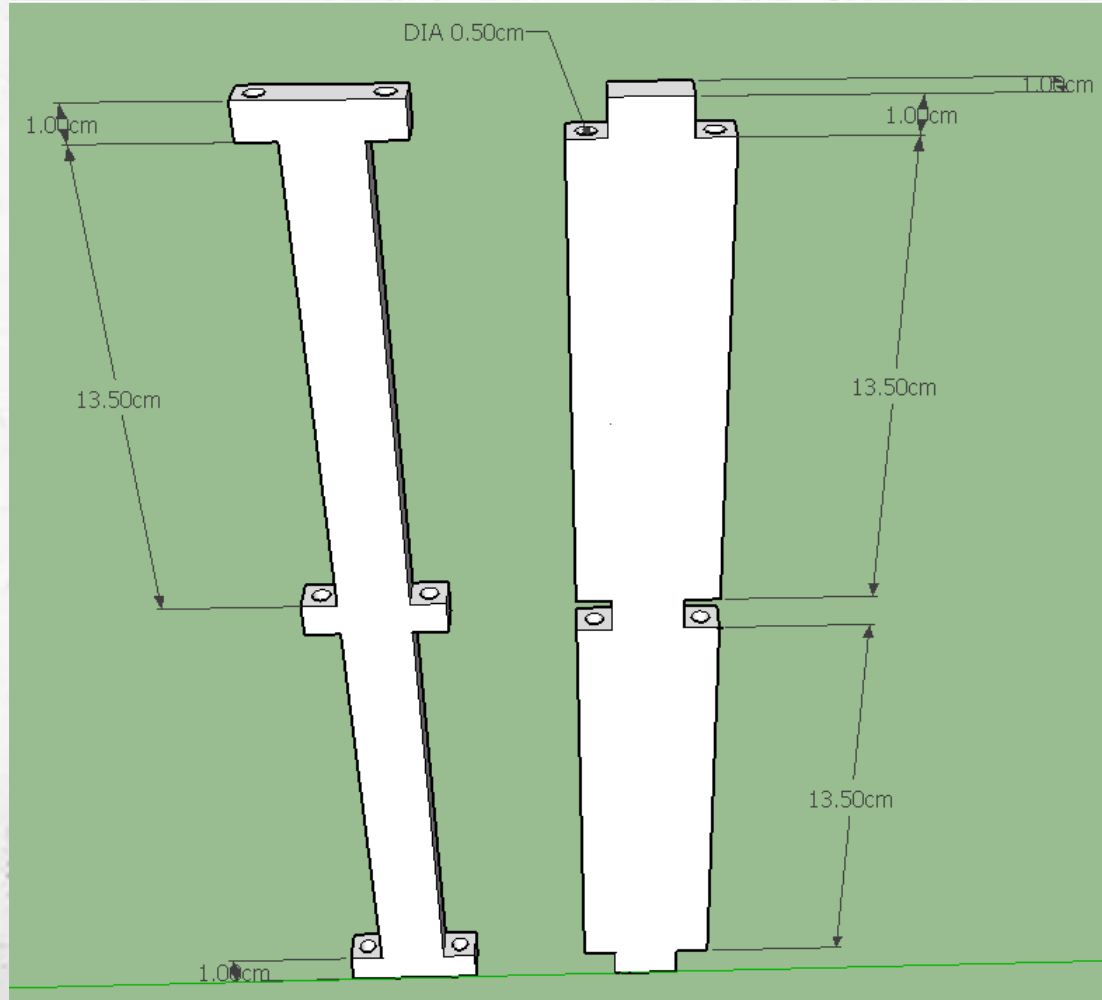
為使水泥緊貼內壁，因此內壁採用內凹0.2公分的結構來達成目的。

Combined Components



3

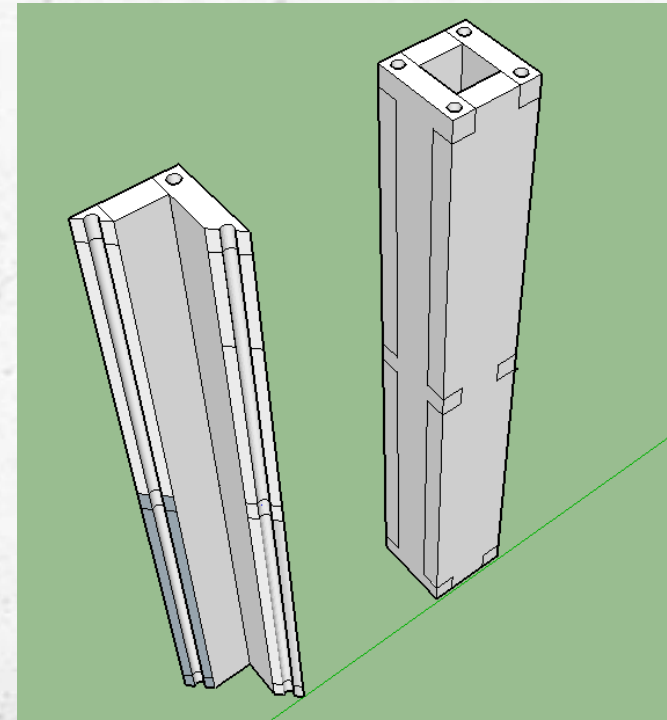
Model Design - Column



+ 大柱

為了方便現場組合架設，採用拼接式結構來取代鐵釘固定。
每片版的拼接處設計成一個貫穿的圓柱，能夠填滿水泥使2板更加牢固。

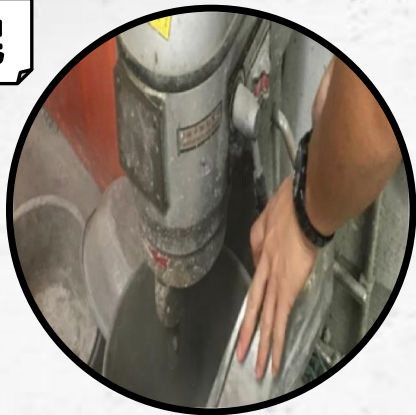
Combined Components



3

Lab Tests

拌水泥



灌漿



靜置



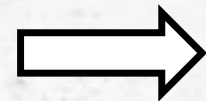
抗壓試驗



蓋平石膏



養護

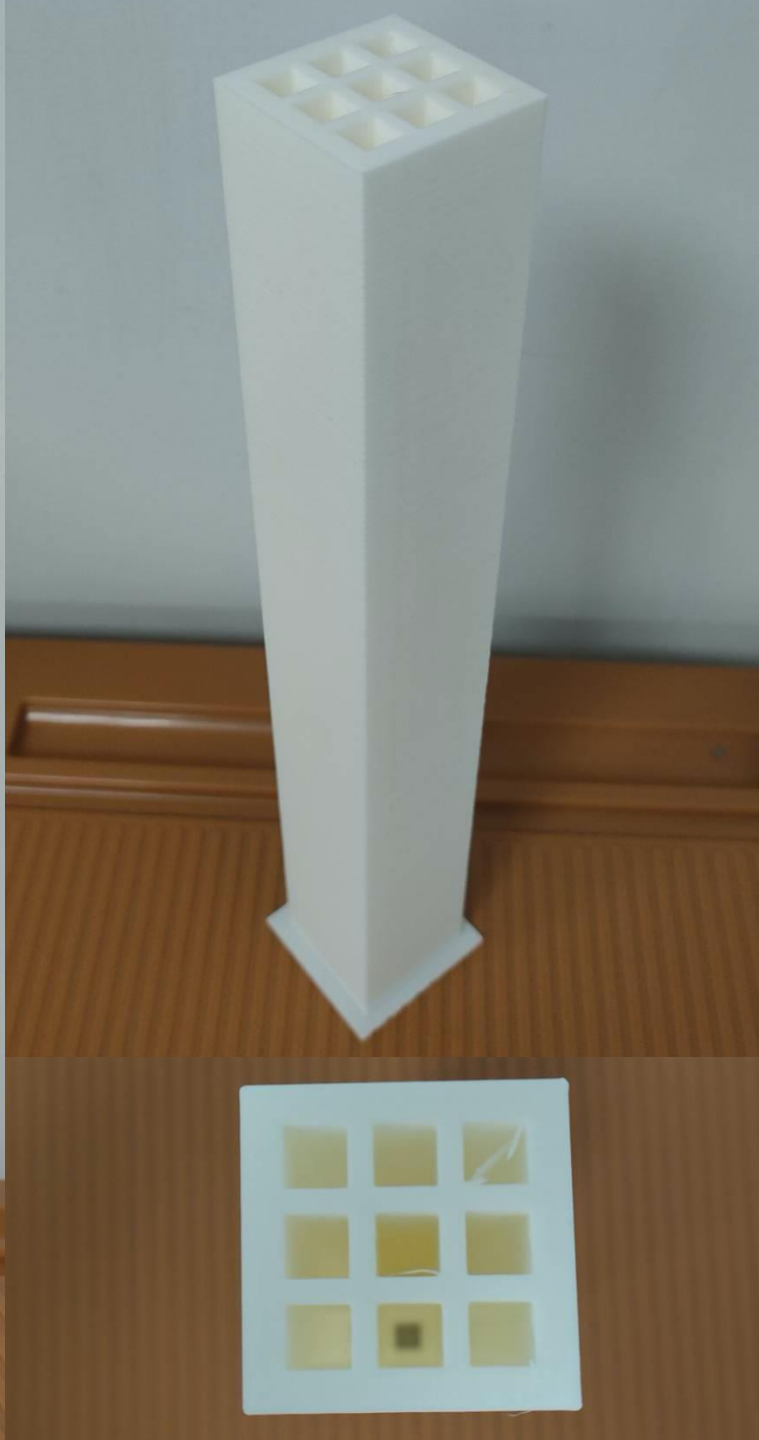
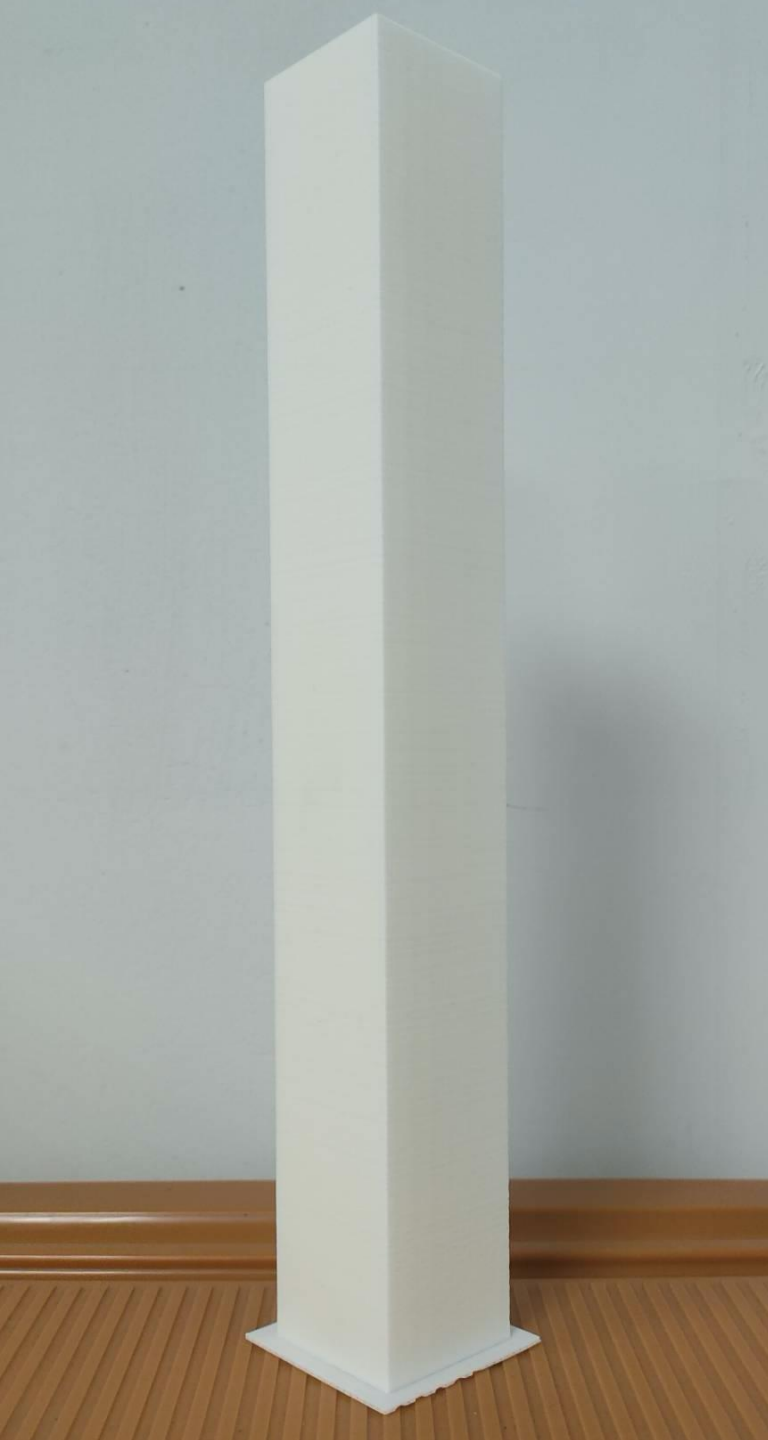




發售日期: 108
地址: 高雄市
發售單位: 樂和實業

801

零件

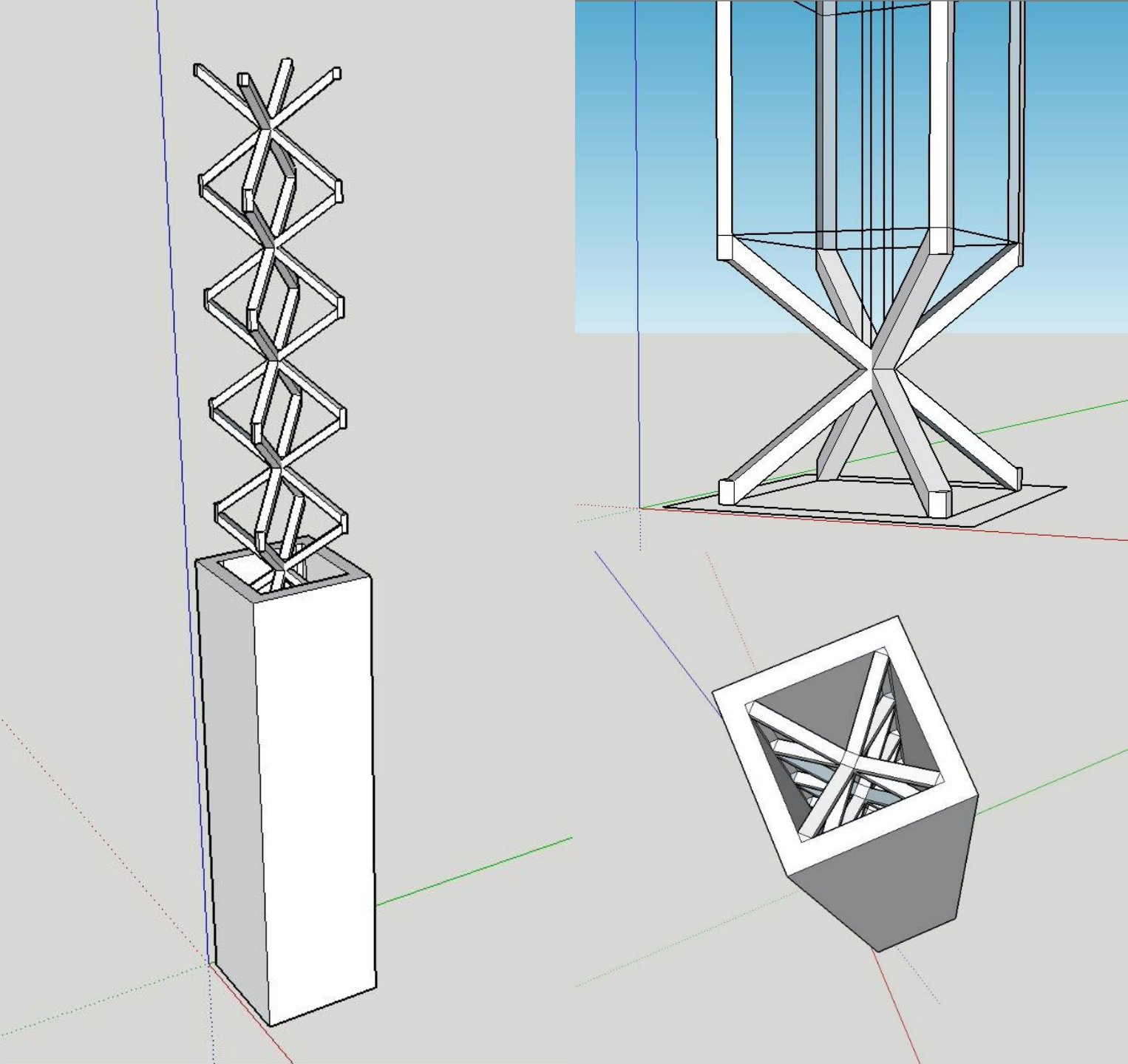


“

4 cm x 4 cm x 30 cm

**Idea comes from intersecting
parallels.**

最一開始設計時，井字厚度保守設計為0.3公分，實際印製後發現可以再更薄，厚薄程度影響結構強度和水泥砂漿灌漿時的工作性，因此要在兩者之間找到平衡。



“

構想三：(4公分*4公分)

想法來源為參考鋼結構中的斜撐，以四個角向對角的斜撐組成。

4 cm x 4 cm

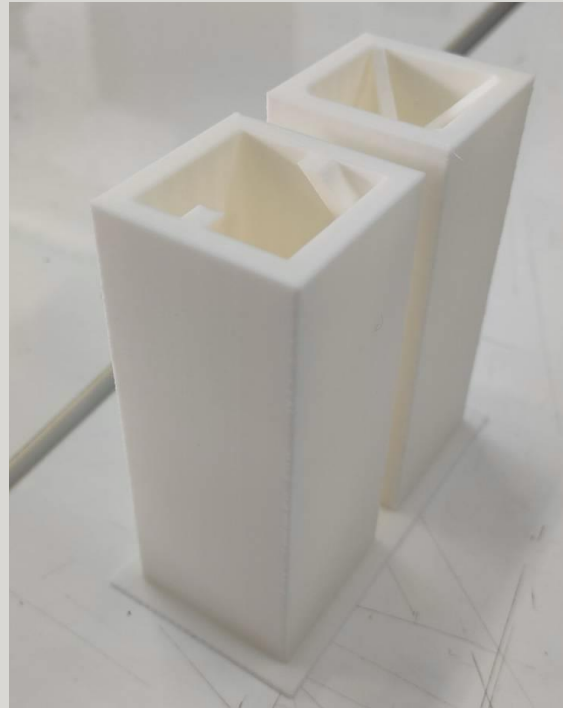
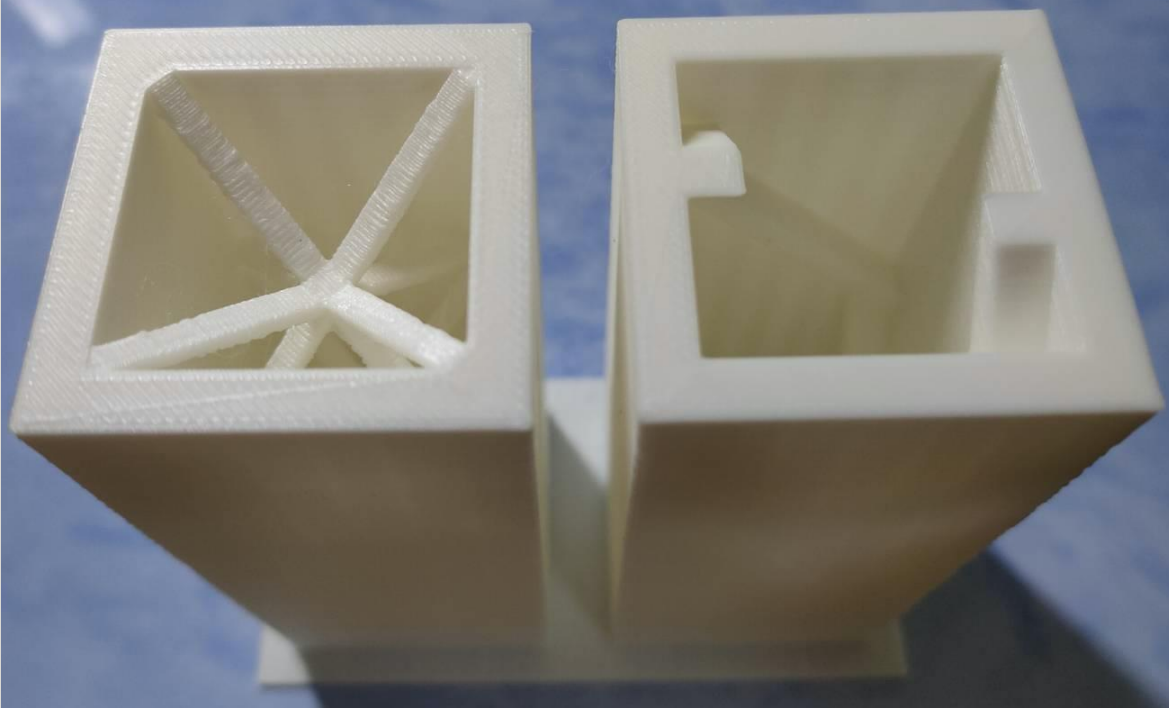
Idea comes from the brace design in structural engineering.

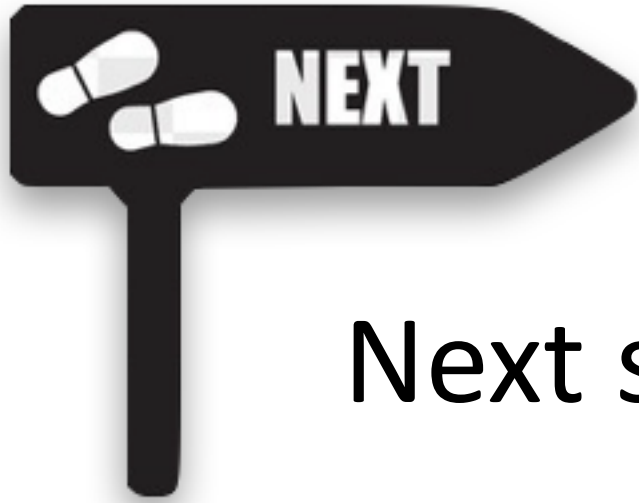


構想二、三(實際成果)：
皆為4公分*4公分*10公分

構想二：內桿為0.5公分厚，雖然印製成功，但我們想要把原來兩個螺旋多增加為四個螺旋，讓結構可以更堅固。

構想三：最底部的斜撐在印製過程中有瑕疵，仍需再修正。





Next step...





Dr. Yi-Min Huang
ninerh@mail.fcu.edu.tw



逢甲大學

Feng Chia University