**Research Assessment Exercise 2020**
**Impact Overview Statement**

**University: The Hong Kong Polytechnic University (PolyU)**
**Unit of Assessment (UoA):16 - Civil Engineering and Building Technology**
**Total number of eligible staff of the university in the UoA: 69**

## (1) Context

The expertise available at PolyU covers a comprehensive spectrum of disciplines in the Built Environment (with architecture being the main exception). The majority of relevant academic staff are members of UoA 16, whilst others are affiliated to UoA 18. **Sustainable Urban Development** is the main focus of UoA 16, working in **(i) Smart Transport and Infrastructure, (ii) Sustainable Materials and Structures, (iii) Building Energy Efficiency, (iv) Construction Health and Study,** (v) Urban Environment, (vi) Urban Geohazards and Mitigation, (vii) Building Environment, (viii) Building Safety and Resilience, and (ix) Digital Construction. The separately submitted Impact Case Studies provide snapshots of the impact achieved in the **first 4 of these 9 areas**. Our key goal is to develop innovative solutions to the problems posed by the massive urbanization process that is occurring internationally and we demonstrate in the **4 Impact Case Studies** engagement with local and multi-national contractors and consulting companies, Hong Kong and mainland Government departments and the general public. Through our research, we also provide direct benefits to the well-being of engineers and other workers employed in all sectors of the construction industry. The general public gains considerably from the enhancements of their urban and building environments that are enabled by our research, which is implicit in our 4 Impact Case Studies. Other notable examples not covered in the submitted case studies include the improved air quality model (WRF-Chem) developed from our Environmental Engineering Group's research into the role of nitrogen chemistry in photochemical smog, which is used extensively by researchers and policy-makers worldwide.

## (2) Approach to impact

PolyU staff all recognize that academic and non-academic impacts are equally important as salary and promotion incentives are offered to reward good performers in both regards. 8 other mechanisms that support the UoA's staff in generating impact beyond academia are described below.

*Professional Practice:* Transfer of the new knowledge our staff generate takes place continuously through professional activities including: Joint Industry Projects participations, Consultancies, Contribution to drafting of Codes and Standards and membership of Government Committees. These conduits enable our scientific discoveries to translate into engineering practices. Typical examples are given in the last section of this statement.

*Tangible Products:* The major output from Civil Engineering research is improved understanding of fundamental aspects and how to apply this knowledge in design and construction for deriving innovative solutions. Most new findings are shared freely through public domain publications, leading to fewer research-lead commercial products, patents and licenses than in some branches of engineering. Nevertheless, during the assessment period, UoA members have filed **58 patents and created marketable products**, such as the anti-heat stress construction worker garments described in our 4$^{th}$ Impact Case Study.

*Training and Professional Development:* Continuing Professional Development (CPD) courses and seminars provide another immediate means of disseminating our research and attracting new projects. During the last 6 years, the UoA's **33 CPD courses and numerous technical seminars**, attracted valuable

feedback and collaboration opportunities that have enabled many joint research projects, consultancies and effective working relationships with many practicing engineers.

*University-Government-Industry (UGI) Consortium for Sustainable Urban Development:* Our UGI Consortium organizes annual one-day fora that bring together our researchers, practicing engineers and government officials to share our latest research on sustainable urban development. This stimulating environment serves to transfer new knowledge and share the benefits of its impact.

*Hong Kong Branches of Chinese National Engineering Research Centres (CNERC):* 2 CNERC Hong Kong Branches were approved in 2015 by the State Ministry of Science and Technology (China) and the Innovation and Technology Commission of the Hong Kong Government (HKG). UoA's staff lead these Branches to deliver additional impact through new engagements with government departments in Hong Kong as well as industrial and professional associations in China, Hong Kong and overseas. In one case, the new Rail Transit Electrification and Automation Engineering Technology Research Centre (CNERC-rail) Branch was commissioned to scrutinize the operational performance of Rio de Janeiro's metro trains in Brazil before the official launch of its Olympic line. In another, the new Steel Construction Centre (CNERC-steel) Branch worked together with the HKG Development Bureau to set up a Steel Construction and Fabrication Committee to develop a more efficient steel construction industry in Hong Kong that will complement conventional reinforced concrete construction.

*Innovation and Technology Development Office (ITDO):* The University's ITDO office boosts research impact through facilitating closer liaison between our staff with local and international industrial enterprises, professional groups, government bodies and research groups. The Office also works to protect the intellectual property of the PolyU community. The ITDO has assisted UoA staff to file **58 patents** in this assessment period.

*PolyU Technology and Consultancy Co. Ltd. (PTeC):* Professional consultancy provides an effective means of achieving impact. The University facilitates this process through its professional consultancy arm, which contracted a total sum of **HK$106 million** for services provided by the members of this UoA over the assessment period.

*Communication and Public Affairs Office (CPA):* Informing stakeholders and the public about our research achievements provides another route to impact, which our CPA coordinates through media releases, interviews, dialogue with the community and other engagement activities.

### (3) Strategy and plans

The UoA will enhance its research impact over the next 6 years by providing resources to maintain existing and facilitate new, collaborative work with a spread of stakeholders. Dedicated administrative and research support personnel will be deployed to strengthen our external liaison activities and identify research projects of mutual interest. The following mechanisms will also be employed to help finance research projects that specifically enhance our external research impact.

*Research Impact Fund (RIF):* Best use will be made of the opportunities created by RGC's recently introduced RIF mechanism to encourage more impact and translational research projects to benefit the wider community and encourage more research collaborations beyond academia. The UoA has been successful in winning four projects in the first round of competitive RIF bidding (announced January 2019) and gained nearly **HK$26 million**, around one eighth of the total awarded across all academic disciplines. The UoA will share its experience in how to achieve success and offer appropriate RIF application coaching to all its academic staff.

*Partnership Research Programme (PRP):* The UoA will capitalize on the opportunities created (in January 2019) by the HKG's Innovation and Technology Commission (ITC)'s PRP to support research and development projects undertaken by private companies with local universities and public research institutes. PRP supports partnership where the external company contributes at least 50% of the research

funds. The UoA will actively identify opportunities to establish PRP links with appropriate companies, building on its close relationship and track record of collaboration with the construction industry.

*Start-up Companies:* The University will encourage and support UoA staff in exploiting their innovations by both applying for international patents and partnering with PhD graduates to develop start-up companies. The UoA will provide additional funds to match the HKG ITC's Support Scheme, which assists universities to start technology businesses and commercialize their research and development results and so accelerate the initial development phase of such start-up companies.

*Guangdong-Hong Kong-Macao Greater Bay Area (GBA):* The UoA will participate actively in the international GBA innovation and technology hub as proposed and promulgated by the Central Government in February 2019. The University organized a Translational Forum on this Theme in April 2019 and will help develop collaborative platforms for coordinated innovation projects and promote commercial applications of technological achievement. The UoA also plans to help set up laboratories in the GBA to further expand our professional services to this area.

*Designated Senior Staff Overseeing Impact:* The UoA will task a senior staff member to encourage, coordinate and monitor translation and impact work. The individual will be charged with reporting progress to the research committee and collecting feedback from staff on how the impact-generation process can be improved. His or her input will be facilitated by offering a reduced teaching load.

**(4) Relationship to case studies**

The Impact Case Studies demonstrate the impact achieved through the mechanisms outlined above in 4 of the UoA's **9 research areas**. The external funding parties invested more than **HK$615 million** in the high-quality research of the UoA, leading to **269 PhD theses** in widely different research areas.

Case 1: The **High Performance Structures** programme achieved its impact through the creation of CNERC-steel; structural performance monitoring services (supported by PTeC) for super-tall structures and long-span bridges; contributions to design code and guidelines in China, US, Germany, the UK and Australia, covering FRP composites and structural uses of steel; and technology transfer by developing an advanced structural design software (NIDA) which has been used widely by international consultancy companies.

Case 2: The **Sustainable Transport and Infrastructure** example shows how the UoA's research was applied to help solve the significant transportation-related problems facing highly populated cities. The transfer of technology facilitated by CNERC-rail and Professional Practice work aided railway safety and assisted in developing low-noise road surface paving technologies and intelligent transportation systems. Other sustainable engineering achievements include facilitating the management of solid waste by improving the use of waste plastics to enhance the performances of asphalt pavement as well as the successful use of construction & demolition waste and waste glass in road pavements. These steps benefit all who live and work in large cities with sustainable infrastructure.

Case 3 : The **Building Life-cycle Optimization and Diagnosis** case reports beneficial economic, human and environmental impacts achieved through Professional Services. Consultancy projects were supported by PTeC, private firm partnerships and partnerships with local government departments that enhanced the energy efficiency of air-conditioning systems and the use of renewable energy. Technology transfer was also effected by patent licensing and two start-up companies that propagate the impact more widely.

Case 4 : The **Enhancing Construction Workers' Health and Safety in Hot Weather** example reports on how civil engineering research lead to new Anti-heat Stress Clothing for construction workers, products that are of great benefit in hot and humid weather. The case study describes the process behind the products' development and on how tangible products were developed with the support of industrial partners.