

**BACKGROUND OF STUDY**

**WHAT IS STREET INLET?**

- An opening functions to **discharge stormwater away** from street
- Various design & configurations to suit street condition



**PROBLEM:**

Often failed to discharge water **efficiently**

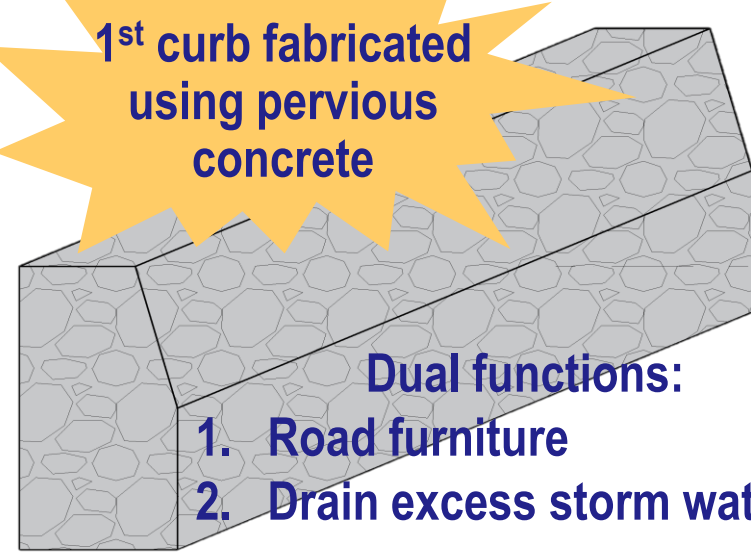
**EFFECTS:**

**Water ponding & urban flash flood**

**WHAT IS NEW PERVIOUS CONCRETE CURB (CURBVIOUS)?**

Simple & practical technology developed from **pervious concrete** which **allow more interception** of excess stormwater runoff on the street

1<sup>st</sup> curb fabricated using pervious concrete



**GAPS**



- NO** report on Malaysian inlets efficiency
- NO** study presents reliability assessment of street inlet
- NO** work on pervious concrete curb

**OBJECTIVES**

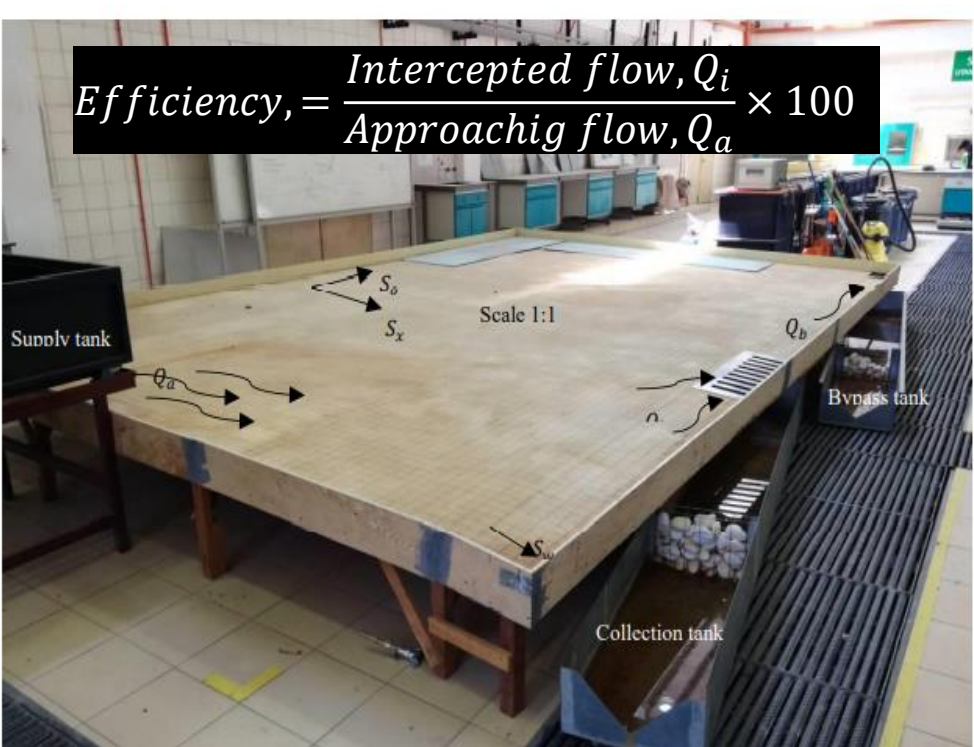
- To **DESIGN** a half roadway full scale (1:1) model in the laboratory
- To **ASSESS** the current hydraulic performance and reliability of several typical type of grate and curb-opening inlets used in Malaysia
- To **ASSESS** the hydraulic performance of a new pervious concrete curb (*Curbvious*) in reducing excess stormwater runoff on the street



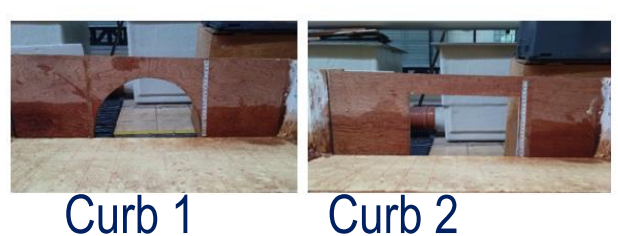
**METHODOLOGY**

**Half Roadway Model (1:1) scale**

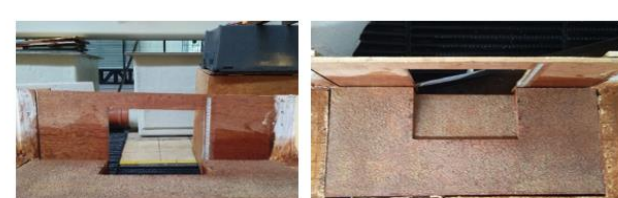
$$\text{Efficiency} = \frac{\text{Intercepted flow, } Q_i}{\text{Approaching flow, } Q_a} \times 100$$



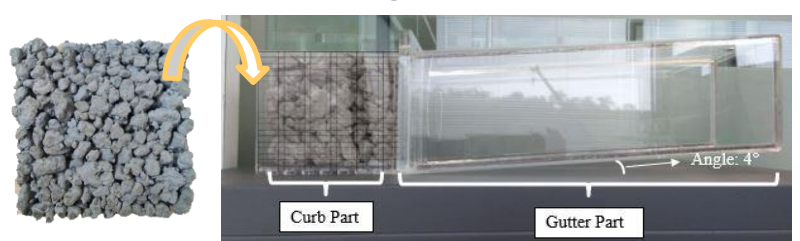
**Curb opening inlet**



**Curbs 3 & 4**

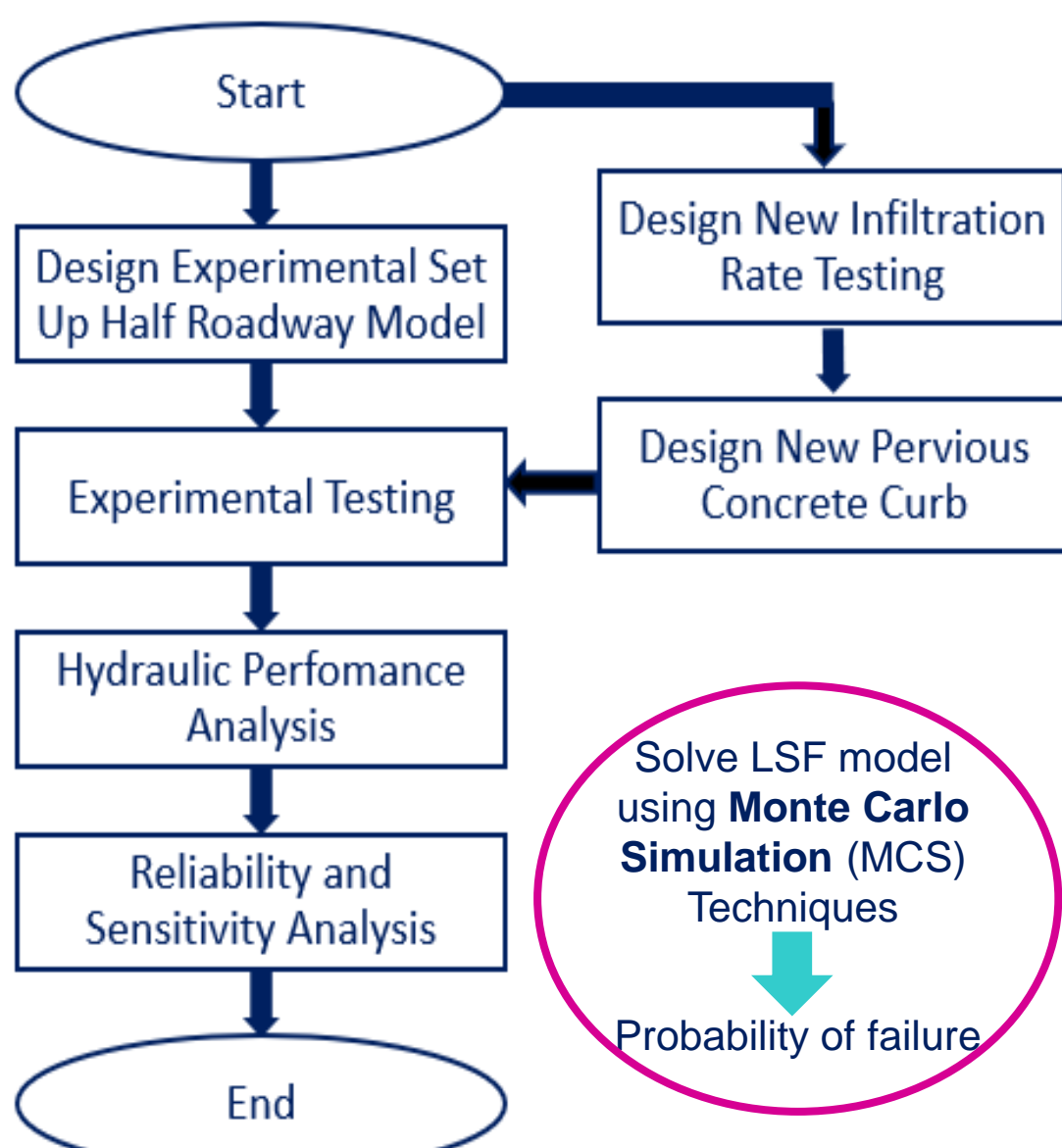


**Newly designed infiltration rate testing device**



\*Mix with the **highest infiltration rate** was selected for *Curbvious* application

**Curbvious with grate inlet**

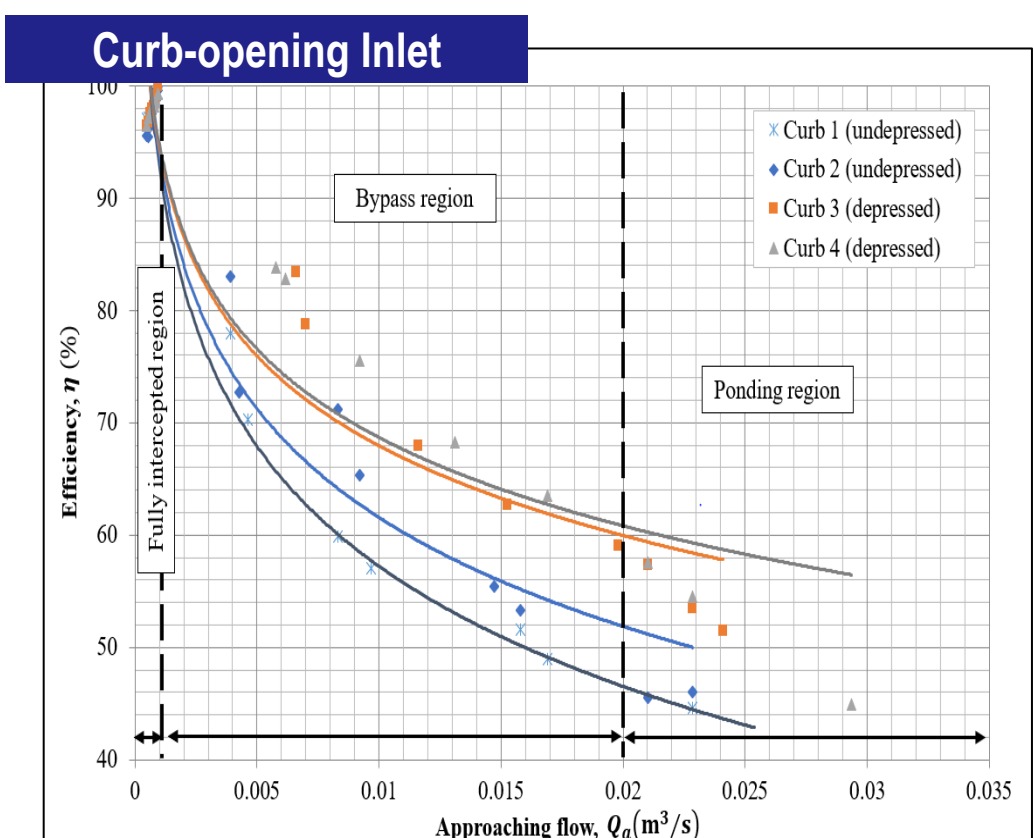
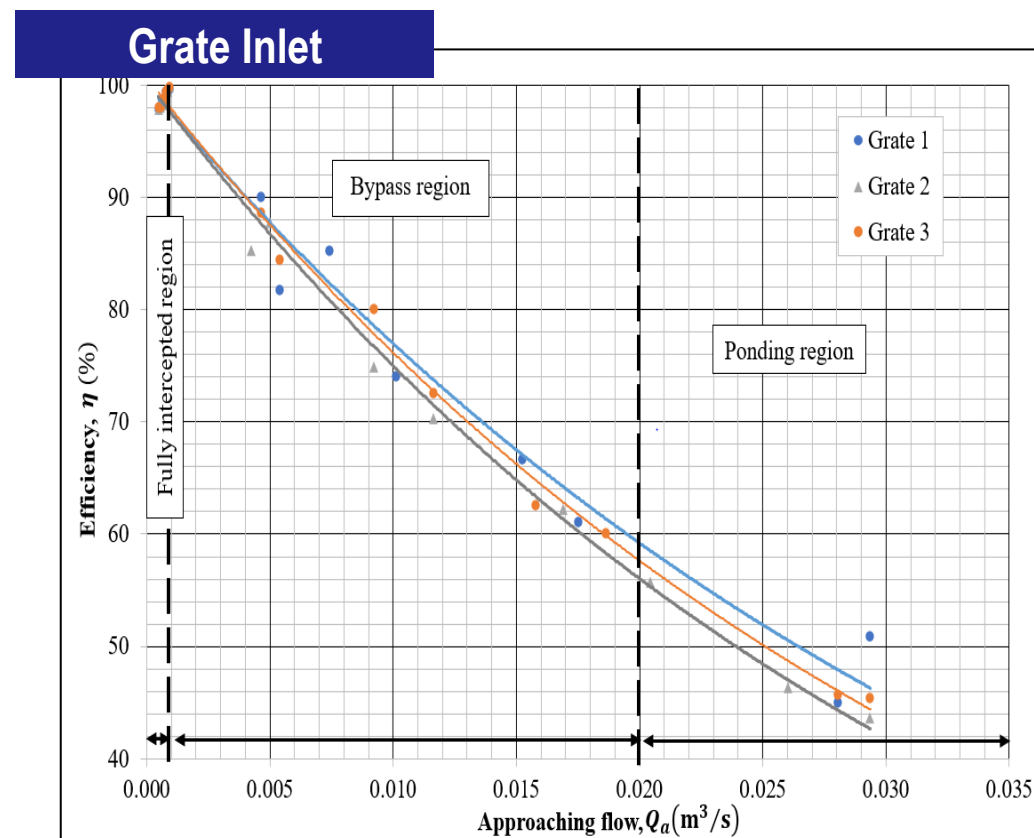


**OUTCOMES**

**Hydraulic Performance of Street Inlet**

- Overall range of efficiency:  
 Grate inlets: 44 to 90%,  
 Curb-opening inlets: 37 to 84%,
- Grate inlet always performed better than curb-opening inlet

INLET TYPE	EFFICIENCY (%)
Grate 1	51 - 90
Grate 2	44 - 88
Grate 3	46 - 89
Curb 1 (undepressed)	37 - 78
Curb 2 (undepressed)	46 - 73
Curb 3 (depressed)	51 - 84
Curb 4 (depressed)	54 - 84

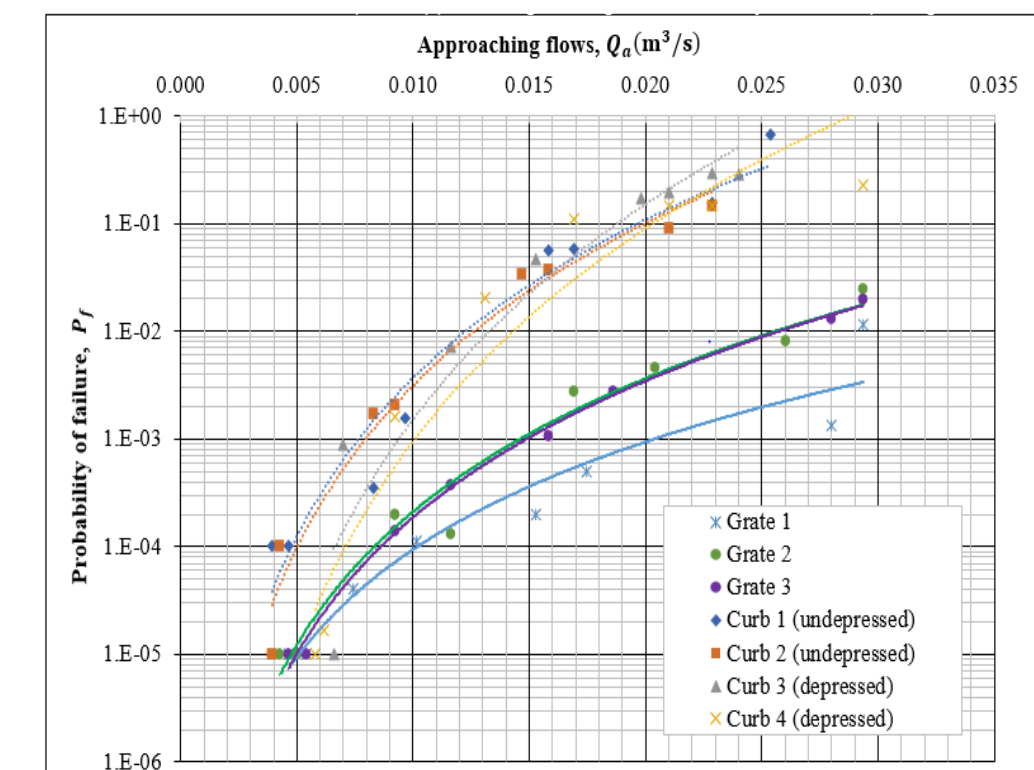


**Reliability Model of Street Inlet**

$$Z = Q_i(\text{theory}) - Q_i(\text{measured})$$

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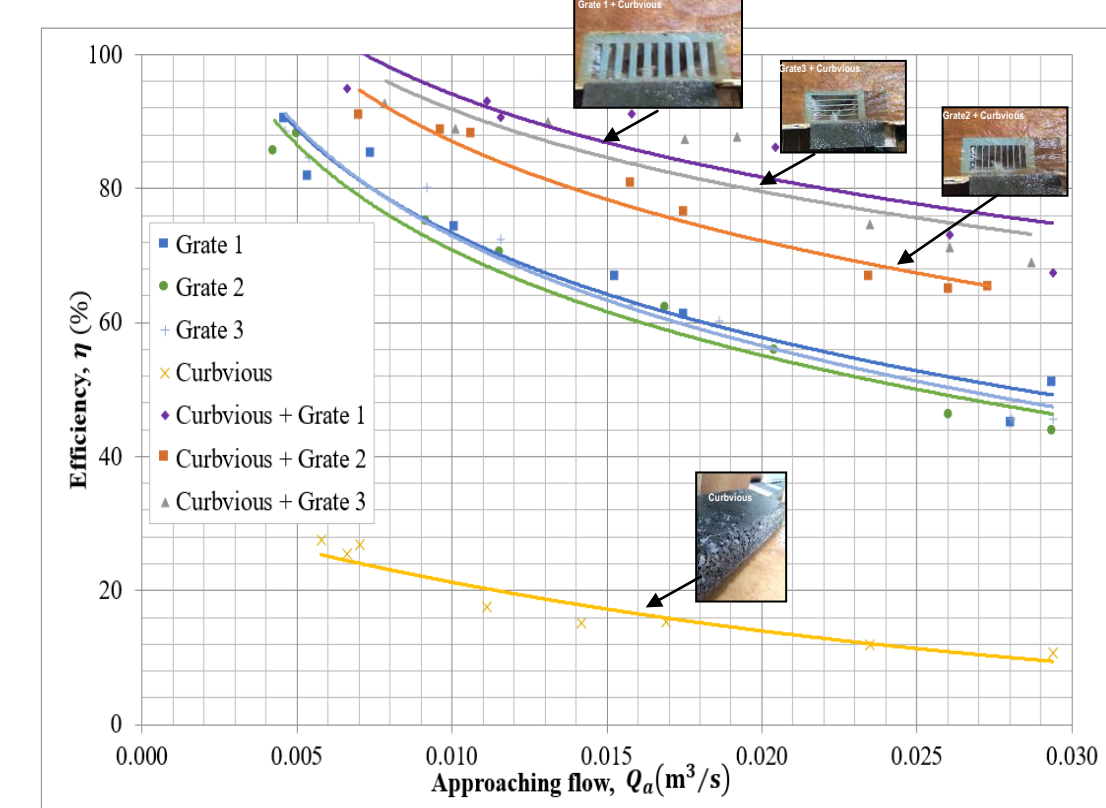
- Probability of failure progressively increases as the approaching flow increases
- Head or water depth over the inlet plays a significant role in determining the street inlet performances



**Hydraulic Performance of New Pervious Concrete Curb**

- Overall range of efficiency:  
 Grate inlets with *Curbvious*: 65 to 95%  
*Curbvious* only: 11 - 27%

TYPE	EFFICIENCY (%)
Grate 1 with <i>Curbvious</i>	68 - 95
Grate 2 with <i>Curbvious</i>	65 - 91
Grate 3 with <i>Curbvious</i>	69 - 93
<i>Curbvious</i>	11 - 27



**CONTRIBUTIONS**

- NEW** street inlet design guidelines
- Stormwater drainage system **ENHANCEMENT** through *Curbvious*



**ACHIEVEMENTS**

**Intellectual Property**



- Curbvious Design Concrete Material (Class 25-01), Filing ID: 19-00381-0101/
- Infiltration Rate Testing (Class 10 - 04), Filing ID: 19 - E0018 - 0101 / -
- New Infiltration Rate Test for Lateral Flows in Pervious Concrete, Filing ID LY2019003391/-
- Curbvious* Trademark - Status: Submitted

**Journal Publications**

- Lateral Infiltration Capacity of Pervious Concrete and Its Performance as Pavement Curb [Status: In Press in J.Mater. in Civ. Eng. (Q1)]
- Probabilistic Assessment for the Capacity of Grate and Curb-Opening Inlets During Floods [In Press in J. Irrig. Drain. Eng. (Q2)]
- Infiltration Rate of Pervious Concrete on Street Curb Application [Status: Published in Int. J. Recent Technol. & Eng. (Q4)]
- Efficiency of Simple Curb Inlet Design in Malaysia [Status: Published in IOP Conf. Ser. Earth Environ. Sci.]

**New Pervious Concrete Curb (*Curbvious*) Awards**

- Gold Medal, Sarawak Innovation & Technology Exposition (SAINTEX 2019)
- Gold Medal, UNIMAS Innovation and Technology Exposition (INTEX 2019)
- Gold Medal, 30th International Invention, Innovation and Technology Exhibition (ITEX 2019)
- Best Invention in Design for Japan Intellectual Property Association Award, 30th International Invention, Innovation and Technology Exhibition (ITEX 2019)
- Silver Medal, International Eureka Innovation Exhibition (i-EIE 2019)
- Bronze medal, Malaysia Technology Expo (MTE 2020)

