STRUCTURES DESIGN MANUAL FOR HIGHWAYS AND RAILWAYS

2013 Edition

AMENDMENT NO. 2/2025

June 2025

Highways Department
The Government of the Hong Kong Special Administrative Region

STRUCTURES DESIGN MANUAL FOR HIGHWAYS AND RAILWAYS

2013 Edition

AMENDMENT NO. 2/2025

INTRODUCTION

The "Structures Design Manual for Highways and Railways – 2013 Edition" (SDM) published by the Government of the Hong Kong Special Administrative Region sets out standards and provides guidance for the design of highway and railway structures in Hong Kong. In 2025, Highways Department reviewed the possible way to improve the resilience of future underpasses against flooding. Following the review, amendments to Chapter 14 of the SDM are proposed. The amendments mainly involve the introduction of flood risk assessment for underpasses to be conducted at preliminary design stage.

As an environmentally friendly measure, amendments to the SDM will no longer be prepared in form of replacement pages. Continuously updated version of the SDM is available in the departmental website for viewing and downloading.

AMENDMENT DETAILS

The following amendments are made :-

1. CHAPTER 14 STORMWATER DRAINAGE

(a) Replace the chapter title with "STORMWATER DRAINAGE AND FLOOD RISK ASSESSMENT".

(b) Add the following clause after clause 14.6:

14.7 FLOOD RISK ASSESSMENT FOR UNDERPASSES

14.7.1 Aims

(1) Underpasses are easily affected by flooding of the surrounding areas. Despite that the drainage systems of underpasses are designed for handling the rainfall discharges along the approach ramps, such systems are not able to handle the additional water coming from the surrounding areas in case of regional flooding.

(2) As flooding of underpasses may need a long time to recover and may pose safety hazards and serious disruption to road traffic, flood risk assessments shall be conducted for all underpasses in order to reduce the flood risk.

(3) The flood risk assessment aims to identify any potential flooding over the surrounding areas by conducting assessment on the combined effects of various environmental parameters with due consideration of climate change projections. If potential flooding is identified, mitigation measures shall be proposed.

(4) Flood risk assessment shall be conducted at the preliminary design stage such that any potential flooding and the associated mitigation measures can be identified early before proceeding to the detailed design.

(5) The flood risk assessment report detailing the methodologies, the computational models, input parameters, output results and proposed mitigation measures shall be circulated to the Drainage Services Department (DSD) for comments.

14.7.2 Design Return Periods

Underpasses which are classified as Critical Infrastructures (CI) shall be designed for flood levels with return period of 200 years. For other underpasses, design flood levels with return period of 100 years shall be adopted.

14.7.3 Classification of Critical Infrastructures

According to Section 3.9, Part 1 of PWDM published by the Civil Engineering and Development Department (CEDD), the classification of underpasses as CI is determined based on the following criteria:

(1) Underpasses that require long recovery time upon hazard impact. That means, the operation of underpasses could not be resumed in short to medium term after the impact of climate-related hazards; or

(2) Underpasses that have a high non-substitutability (the reliance on the underpasses to serve its function for the community). Some underpasses will be more critical if they are not easily substituted or replaced, or their function(s) could not be met by alternative means. For instance, underpasses located at roads where there is no alternative route to a destination are deemed to satisfy this criterion; or

(3) Underpasses that are critical to people movements and economic activities. That means, the impact of climate-related hazards will cause disruption to territorial/regional wide service/daily life or economic impact. For instance, underpasses located at Red Routes are deemed to satisfy this criterion.

14.7.4 Methodologies of Assessment

(1) In general, flooding falls under two main categories, i.e. rainfall flooding and coastal flooding. Rainfall flooding is caused by overflow of the drainage system as a result of heavy rainfall. Coastal flooding is caused by impact of extreme sea levels, storm surges and waves from the sea that penetrate the coastline defence. These two types of flooding have different sources of impacts and hence different assessment methodologies shall be adopted. The methodologies to be adopted shall be determined case by case in consideration of the location and layout of the underpasses and the drainage characteristics of the nearby catchment areas.

(2) The environmental parameters adopted (including rainfall intensity, sea level, storm surge and wave condition) shall refer to PWDM published by CEDD and Stormwater Drainage Manual published by DSD.

(3) The environmental parameters adopted shall include the effects of climate change in far future with very high greenhouse gas emissions scenario (i.e. the projected values at end 21st century with climate change scenario SSP5-8.5).

14.7.4.1 Rainfall Flooding Assessment

(1) Rainfall flooding assessment shall be conducted by model simulations with the design combinations of rainfall, storm surge and sea level.

(2) The following combinations of environmental parameters with climate change projections shall be considered:

<u>For 200-year return period flood level</u>:

Combination 1:
200-year return period extreme rainfall intensity + 10-year return period storm surge increase + 10-year return period extreme sea level

Combination 2:
10-year return period extreme rainfall intensity + 200-year return period storm surge increase + 200-year return period extreme sea level

<u>For 100-year return period flood level</u>:

Combination 1:
100-year return period extreme rainfall intensity + 10-year return period storm surge increase + 10-year return period extreme sea level

Combination 2:
10-year return period extreme rainfall intensity + 100-year return period storm surge increase + 100-year return period extreme sea level

(3) The assessment shall be conducted by running computational hydraulic models representing the catchment areas that will affect the underpasses. The input environment parameters and their combinations shall refer to Clauses 14.7.4(2) and 14.7.4.1(2). The models shall be developed based on previous drainage studies/drainage impact assessments, including but not limited to the DSD Drainage Master Plan Studies.

(4) The computational hydraulic models shall incorporate the planned interfacing projects, including any planned drainage improvement or modification works.

(5) The computational output shall be the predicted flood levels of adjacent ground of the underpasses, in particular near the entrance of the approach ramps, along the approach ramps and near the entrances of the underpasses.

14.7.4.2 Coastal Flooding Assessment

(1) Coastal flooding assessment shall be conducted if the underpasses are:

(a) located within 30 m of the seawall cope-line, irrespective of the levels of crest of seawall and the ground levels; or

(b) located at coastal areas where the crest of seawall and ground levels are lower than the extreme sea level, with a return period defined in combination 3 of Clause 14.7.4.2(2).

(2) The following combinations of environmental parameters with climate change projections shall be considered:

<u>For 200-year return period flood level</u>:

Combination 1:
200-year return period extreme wave condition + 200-year return period storm surge increase + 10-year return period extreme sea level

Combination 2:
100-year return period extreme wave condition + 100-year return period storm surge increase + 100-year return period extreme sea level

Combination 3:
10-year return period extreme wave condition + 10-year return period storm surge increase + 200-year return period extreme sea level

<u>For 100-year return period flood level</u>:

Combination 1:
100-year return period extreme wave condition + 100-year return period storm surge increase + 10-year return period extreme sea level

Combination 2:
50-year return period extreme wave condition + 50-year return period storm surge increase + 50-year return period extreme sea level

Combination 3:
10-year return period extreme wave condition + 10-year return period storm surge increase + 100-year return period extreme sea level

(3) Coastal flooding can be due to sea inundation or wave inundation. If the crests of the seawalls are lower than the extreme sea levels with a return period defined in combination 3 of Clause 14.7.4.2(2), sea inundation will occur. If the crests of the seawalls are higher than the extreme sea levels mentioned above, but lower than the wave run-up, wave inundation will occur. Different assessment methodologies shall be adopted for these two kinds of inundations.

(4) For sea inundation, the predicted flood levels shall be the extreme sea levels (coupled with storm surge increase).

(5) For wave inundation, the flood levels shall be predicted by considering the wave overtopping rate and the rate of water flowing back to the sea by gravity in between successive wave crests. For calculating the wave overtopping rate, the designer can make reference to Part 4 of PWDM published by CEDD, or other suitable international standards. For calculating the rate of water flowing back to the sea, reference can be made to commonly used formula on end depth discharge relationship for free overfall, such as Rouse 1949 or Anastasiadou-Partheniou and Hatzigiannakis 1995.

(6) Since the effects of sea inundation and wave inundation are far beyond the effect of rainfall, the effect of rainfall shall be neglected.

(7) The output of coastal flooding assessment shall be the predicted flood levels of adjacent ground of the underpasses, in particular near the entrance of the approach ramps, along the approach ramps and near the entrances of the underpasses.

14.7.5 Underpasses That Have A Risk of Flooding

Based on the output of the computation models, an underpass is considered to have a risk of flooding if the predicted flood levels of the adjacent ground are higher than the entrance of the approach ramps, the side walls of the approach ramps, or the side walls along the top of the underpass entrances.

14.7.6 Mitigation Measures

(1) If a risk of flooding is identified for an underpass, the designer shall propose measures to mitigate the risk such that predicted flood levels will not exceed the entrance of the approach ramps, the side walls of the approach ramps, or the side walls along the top of the underpass entrances. Possible measures may include:

(a) Elevating the entrance of the approach ramps above the predicted flood level;

(b) Elevating the side walls of the approach ramps and the side walls at the top of the underpass entrances above the predicted flood level;

(c) Providing permanent flood walls at nearby areas to protect the underpass from flooding;

(d) Improving the drainage system of nearby areas to lower the flood level; and

(e) Improving the coastal defence along nearby shoreline.

(2) The designer shall seek maintenance parties' views on the proposed mitigation measures.