Building and Construction Authority

An MND Statutory Board

In Collaboration With

THE INSTITUTION OF ENGINEERS SINGAPORE

ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE

Our ref: APPBCA-2024-26

20 Dec 2024
See Distribution List

For enquiries, please contact:
Building Engineering Group (#12-01)
Tel: 1800 3425 222 (1800-DIAL-BCA)
or use our Online Feedback Form at:
https://www.bca.gov.sg/feedbackform/

Dear Sir/Mdm,

Guidelines for standard performance tests on composite wall system of concrete Prefabricated Prefinished Volumetric Construction (PPVC) project.

Objective

This circular aims to provide guidance to industry on standard performance tests to be carried out for concrete PPVC projects adopting composite wall systems.

Background

2 With the eco-system for PPVC systems being more established, BCA has streamlined regulatory process allowing use of PBU and PPVC systems without In-Principle Acceptance (IPA) issued by the Building Innovation Panel (BIP) in the circular issued on 31 Jan 2023. QPs will continue to ensure the design and construction of PPVC systems shall meet the required performance and objectives set in the Building Control Regulations.

3 For concrete PPVC project adopting composite wall system where structural wall is formed by two individual precast panels bonded together through grouting and connectors, performance tests are required to ascertain the composite wall can perform as a monolithic cast reinforced-concrete wall. Due to lack of guidance in current building codes and standards for such innovative composite wall systems, BCA observed inconsistency in performance tests carried out, including acceptance criteria and number of tests, for composite wall systems of concrete PPVC projects.

Guidelines for standard performance tests on composite wall system of concrete PPVC project

4 The guidelines (refer to Annex A) aim to provide a set of standard performance tests and its acceptance criteria to verify the required performance hence ensuring structural safety of composite wall systems. It also provides guidance on number of tests that recognises and allows lesser tests for existing composite wall systems which were adopted successfully in past concrete PPVC projects. The guidelines were developed by a working group consisting of industry representatives and academia with expertise and experience in concrete PPVC design and construction, and in consultation with ACES & IES members.

5 Nothing contained in this circular is meant to replace or negate the need to comply with the provisions of the Building Control Act 1989 and the building regulations. Please note your duties under the Building Control Act and building regulations and ensure these duties are discharged in the course of you performing building works.

Clarification

Please disseminate the contents of this circular to your members. Should you need any clarification, please submit your enquiry through BCA's Online Feedback Form at https://www.bca.gov.sg/feedbackform/ or call us at 1800 342 5222.

Yours faithfully

DR TRAN CHI TRUNG
DIRECTOR
BUILDING ENGINEERING GROUP
BUILDING AND CONSTRUCTION AUTHORITY
for COMMISSIONER OF BUILDING CONTROL

ER CHAN EWE JIN
CHAIRMAN, INFRASTRUCTURE CLUSTER
INSTITUTION OF ENGINEERS
SINGAPORE (IES)

ER CHUCK KHO
PRESIDENT
ASSOCIATION OF CONSULTING
ENGINEERS SINGAPORE (ACES)

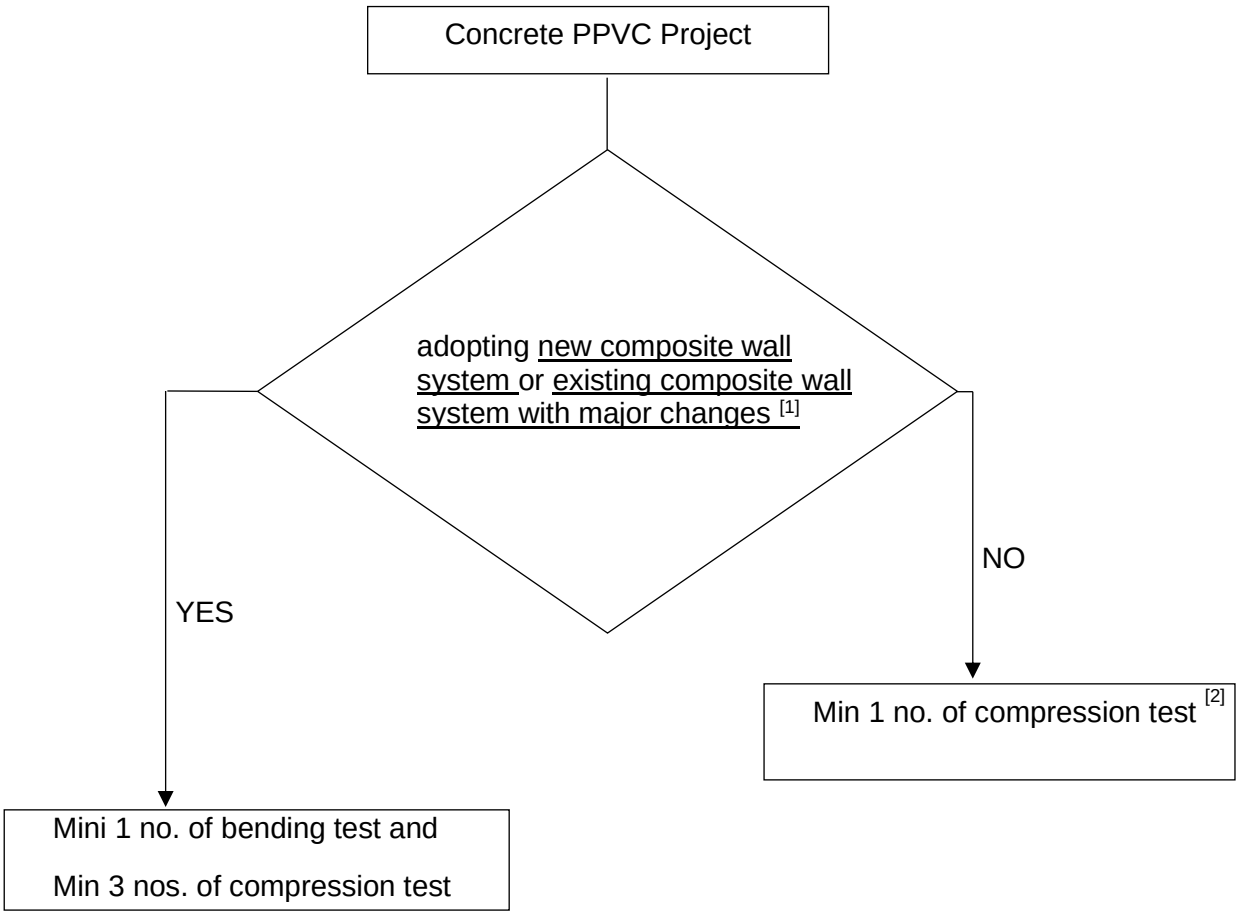
Annex A - Guidelines for Standard Performance Tests on composite wall system of concrete PPVC project

Table 1: Standard Performance Tests and Acceptance Criteria

Type of test	No. of tests	Acceptance criteria
Bending test	Refer to Flowchart 1	a) The test results should be compared against the ultimate moment resistance M_u without applying material partial safety factors (see Figure 1). b) The ultimate failure mode must not be governed by delamination at the grout joint. c) The effective crack stiffness of the composite wall panel, determined from the test, will be used by the Qualified Person (QP) in the structural analysis.
Compression test	Refer to Flowchart 1	a) Test results should be evaluated against the characteristic compression resistance, i.e., $0.85f_{ck}A_c$ for concrete and $1.0f_{yk}A_s$ for steel, to establish a partial composite factor for determining the design resistance N_u of the composite wall (if the test result is less than N_u). The partial composite factor must not be less than 0.5. b) Load-displacement behaviour must remain elastic under service load conditions. c) No structural cracks should appear under service load.
Vertical shear bond test *(refer to Figure 2. for recommended test set up)*	Min. 3 nos.*	The test results should be verified against the required shear bond strength, calculated using the formula from SS EN 1992-1-1, Clause 6.2.5: $v_{Rdi} = c.\alpha_{ct}.f_{ctk,0.05}$ with $c = 0.4$) ***Note**: The grout material and interfacial roughening method must be specified in the approved plan.*
Connector pull-out test	Min. 3 nos.*	The test results should be verified against the required 1% of the design compression load $0.01N_{Ed}$ (a minimum of 3 connectors to be provided in the vertical direction of the wall).
Vertical coring test	Min. 3 nos.*	The test results should be verified against the specified characteristic concrete strength of the composite wall.

** If 1 test failed, another 2 additional tests to be carried out for further verification.*

FLOWCHART 1 – Procedure to determine number of bending test and compression test on composite wall system of concrete PPVC project

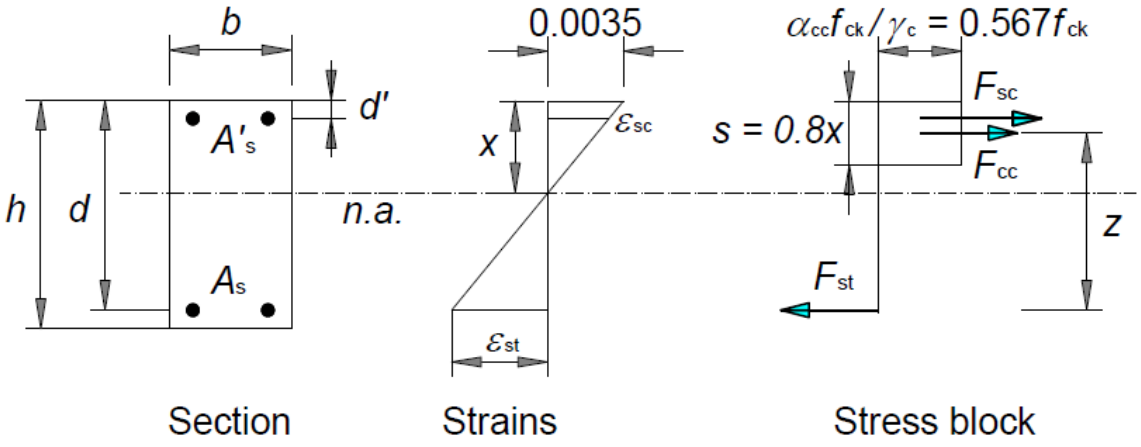


Note:

[1] Major changes refer to one or more of the followings:

- *(a) Composite/precast wall thickness*
- *(b) Rebar and connector details*
- *(c) Interfacial roughness*
- *(d) Material grades*
- *(e) Wall height and its support conditions*

[2] If the existing composite wall system is fabricated by the same precaster using the same fabrication method, the Qualified Person (QP) may apply for a waiver of compression test.



$$M_u = F_{cc} z_{lim} + F_{sc}(d - d') = 0.36 f_{ck} bd \times 0.82d + f_{yk} A_s' \left(d - d'\right)$$

Figure 1. Ultimate moment resistance without material partial factors (i.e. γ_c and γ_s = 1.0)

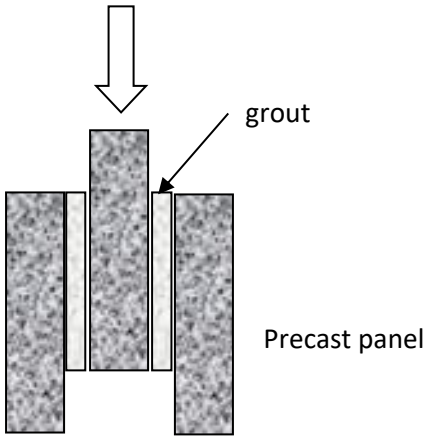


Figure 2. Recommended vertical shear bond test set up