

CLIMATE RESILIENT GUIDELINES

FOR SCHOOL AND
HEALTH FACILITIES

BUILDING SAFE, HEALTHY AND
SUSTAINABLE COMMUNITIES
IN PAKISTAN



A RESILIENT PAKISTAN
FOR A BETTER
TOMORROW



HEAT
RESILIENT



FLOOD
RESILIENT



DISASTER
RESILIENT



ENERGY
EFFICIENT



ECO-FRIENDLY
SOLUTIONS



CLIMATE
ADAPTATION



WATER
RESILIENCE



DISASTER
RISK REDUCTION



HEALTH &
WELL-BEING



SUSTAINABLE
DESIGN



Document control

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These Guidelines are a code companion for design. They do not replace the Building Code of Pakistan, a site investigation, a signed design, a decision of the Authority Having Jurisdiction, or the project-specific judgement of a competent engineer. The intended result is a traceable design basis that records hazards, design horizons, selected criteria, calculations, review decisions and residual risks.

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Abbreviations

Term	Meaning
AHJ	Authority Having Jurisdiction
ASCE/SEI	American Society of Civil Engineers / Structural Engineering Institute
BCP-2021	Building Code of Pakistan 2021
DFL	Design flood level
FRP	Fiber-reinforced polymer
MEP	Mechanical, electrical and plumbing
PEC	Pakistan Engineering Council
PMD	Pakistan Meteorological Department
S_s / S_1	Mapped 0.2-second and 1-second spectral response accelerations
URM / CM	Unreinforced masonry / confined masonry
WASH	Water, sanitation and hygiene
ACI	American Concrete Institute
ASCE 24	ASCE/SEI 24, Flood Resistant Design and Construction
BMZ	Federal Ministry for Economic Cooperation and Development, Germany
CD-CRI	Capacity Development for Climate-Resilient Infrastructure
CM&QA	Construction Management and Quality Assurance
DCR	Demand-capacity ratio
EIA	Environmental Impact Assessment
GESI	Gender equality and social inclusion
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GLOF	Glacial lake outburst flood
IBC	International Building Code
IEE	Initial Environmental Examination
KnK	Kokkyo naki Kodomotachi (Children without Borders) Japan
NAP	National Adaptation Plan of Pakistan, 2023
NBS	Nature-based solutions
NDMA	National Disaster Management Authority
NDRMF	National Disaster Risk Management Fund
O&M	Operation and maintenance
PEPA	Pakistan Environmental Protection Act 1997
PSEAH	Protection from sexual exploitation, abuse and harassment
SHA	Structural Health Assessment
WHO	World Health Organization

Glossary

These terms control whether a requirement of these Guidelines applies. They are defined here so that their application is not left to be settled at the Authority Having Jurisdiction or at certification.

Term	Meaning
Competent	Holding the qualification, registration, experience and resources appropriate to the task, and accountable for it. Where these Guidelines require a competent assessment, the project shall record who carried it out and on what basis.
Material (adjective)	Capable of changing a design decision, an acceptance, a cost or a safety outcome. A hazard, interaction or deficiency is material where disregarding it would alter the design basis or the residual risk recorded.
Design event	The hazard event, stated with its return period or scenario, datum and source, against which the design criteria are set.
Check event	A more severe event than the design event, applied to test that failure is progressive and not sudden, and that life safety and evacuation remain available.
Exceedance	The condition in which the actual event is greater than the design event. These Guidelines require the consequence of exceedance to be stated, not assumed absent.
Low-regret	A measure whose cost is small relative to the works and which remains useful across the plausible range of future conditions, so that it is defensible whether or not the projected change occurs.
Passive survivability	The period for which a space remains usable for its function without mains power or mechanical cooling, stated in hours or days at a defined internal condition.
Degraded state	The condition of a facility in which one or more systems on which its function depends are impaired but the facility remains occupied or in use.

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1 Introduction, Scope and Application

These Guidelines set out how a school or health facility in Pakistan is sited, designed, repaired or reconstructed so that it withstands the hazards acting on it and continues to serve its public function afterwards.

1.1 Purpose

Resilience is not a claim made about a finished building. It is the traceable consequence of decisions taken about where a facility is placed, what hazards it is designed against, how its load paths and details are resolved, how it is built and inspected, and how it is maintained. These Guidelines fix those decisions and the evidence each requires.

Resilience is not a single structural property. Figure 1.1 sets out the six layers through which a facility keeps or loses its public function.

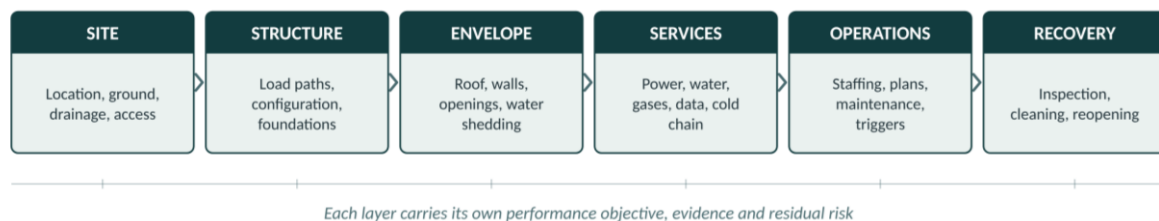


Figure 1.1 Resilience layers of a school or health facility

1.2 Scope

Table 1.1 Scope and boundary of these Guidelines

Included	Boundary
New construction, reconstruction, repair and retrofit of schools and health facilities	Assessment of the structural condition of an existing building precedes design and is a separate engineering exercise.
Seismic, flood, wind, landslide, deterioration and fire hazards	Hazards outside this set that are material at a site shall be added to the design basis rather than omitted.
Effects of changing climate on environmental actions	No allowance is applied to a hazard without a stated mechanism, source and design horizon.
Siting, design criteria, standard details and compliance evidence	Construction method statements and site quality control are the responsibility of the construction supervision team.

1.2.1 The hazard set addressed by these Guidelines as facility design cases is seismic, flood, wind, landslide and ground instability, climate-aggravated deterioration, extreme heat, and fire and life safety. That set matches the CD-CRI programme hazard framework with the exception recorded at clause 1.2.2.

1.2.2 Glacial Lake outburst flood (GLOF), debris flow and hyper concentrated flow are not treated as facility design cases in these Guidelines. Their magnitude, timing and flow composition are governed by catchment and glacial conditions many kilometers upstream of a facility and are

not controllable by criteria applied at the building. Design criteria that a district designer cannot evidence produce non-compliance rather than partial compliance. These hazards are therefore addressed by siting, screening, avoidance and referral to specialist assessment at clause 5.3, and through the Structural Health Assessment Manual and the digital SHA and environmental screening tool identified at clause 1.6. Where a specialist assessment returns design actions for a specific site, those actions govern and are recorded in the design basis report at clause 4.3.

Table 1.2 CD-CRI programme hazard set and where each hazard is addressed

Programme hazard	Treatment in these Guidelines	Where it is addressed
Seismic	Facility design case	Chapter 6; ground model at Chapter 9; material behaviour at Table 11.1
Flood: riverine, pluvial, hill torrent, drainage surcharge, groundwater, coastal	Facility design case	Chapter 7; site screening at cl. 5.3
Wind and storm	Facility design case	Chapter 8
Landslide, slope and ground instability	Facility design case	Chapter 9
Glacial lake outburst flood (GLOF)	Not a facility design case. Sited against by screening, avoidance and referral. Where avoidance is not possible, designed to specialist-derived actions.	Scoped out at cl. 1.2.2; screening trigger at cl. 5.3.1; route where avoidance is not possible at cl. 5.3.2, cl. 7.4.3 and cl. 9.3.3
Debris flow and hyper-concentrated flow	Not a facility design case. As for GLOF above.	As for GLOF above
Climate-aggravated deterioration	Facility design case	Chapter 10, cl. 10.1 to 10.3; material and build-up selection at Chapter 11
Extreme heat	Facility design case	Cl. 3.6 and cl. 3.6.2; cl. 10.4 and Table 10.4; build-ups at cl. 11.3
Fire and life safety	Facility design case	Cl. 10.5; cascading sequences at cl. 10.6

1.2.3 Table 1.2 maps the CD-CRI programme hazard set against these Guidelines. Every programme hazard is addressed. No programme hazard is omitted, and the two hazards that are not treated as facility design cases are addressed by the route stated in the table and are not left to the designer to discover.

1.3 What these Guidelines do not establish

These Guidelines do not establish a national climate projection where the competent national authority has not published one; a design flood level without hydrological and hydraulic evidence for

the site; a geotechnical or slope-stability conclusion without investigation and analysis; or an approval that has not been issued.

1.4 Statement hierarchy

Table 1.3 Statement hierarchy and the weight carried by each label

Label	Meaning
Governing requirement	A requirement of adopted law, code, approval or contract. The exact source and edition are cited.
Design requirement	A requirement of these Guidelines, applied once adopted for the project.
Recommended practice	A preferred method that may be varied with recorded reasons and reviewer acceptance.
Engineering judgement	A project-specific decision by the responsible engineer, with assumptions, evidence and limitations recorded.

1.5 Minimum design deliverables

Table 1.4 Minimum design deliverables and where each is defined

Deliverable	Content	Ch.
Design basis report	Facility, scope, code basis, hazards, performance objectives, design horizons and analysis routes.	4
Climate design record	Baseline, dataset, scenario, horizon, transformation and adopted values.	3
Site and multi-hazard record	Hazards, exclusions, access, dependencies and compound modes.	5
Hazard design schedules	Criteria, calculations, drawings, checks and residual risks.	6 to 10
Facility resilience schedule	Continuity, critical services and operating modes.	11
Intervention decision	Repair, retrofit, reconstruct or relocate and the strengthening measures selected.	12
Detail package	Project details developed from the standard details, with specifications and hold points.	13
Design compliance certificate	Signed summary of the design basis, deviations, review record and residual design risk. Issued before construction.	14
Construction and handover conformity certificate	Signed summary of inspections and tests, non-conformance closure, as-built information, commissioning and residual operational risk. Issued after commissioning.	15

1.6 Relationship to other CD-CRI knowledge products

These Guidelines are one product of the CD-CRI Output 1.5 knowledge series. They govern design. They do not carry assessment method, construction control or site workmanship, each of which is held by a companion product. Where a task falls outside these Guidelines, it is routed as follows.

Table 1.5 Routing to the other CD-CRI knowledge products and to the digital tool

Task	Governing product	Interface with these Guidelines
Condition and hazard assessment of an existing facility	Structural Health Assessment (SHA) Manual and Framework	The assessment output is an input to the design basis report at clause 4.3 and to the intervention selection at Chapter 13.
Rapid visual screening of a facility or site	RVS proforma set and user manual	Screening results establish whether a competent assessment is required before design criteria are fixed.
Construction control, inspection and quality assurance	Construction Management and Quality Assurance (CM&QA) Protocols	Hold and witness points referenced at clause 15.6 are executed under the CM&QA Protocols.
Site workmanship and field verification	Engineer's Field Handbook	The Field Handbook carries the site-level execution of the details identified at Chapter 14.
Structural rehabilitation and retrofitting method	Structural Rehabilitation and Retrofitting Guidelines	Technique families at clause 13.3 are developed in full in that product.
Data capture, screening records and reporting	Digital SHA and environmental screening tool	Facility classification, hazard screening and the environmental screening at clause 2.4 are recorded in the digital tool. Where the tool and these Guidelines return different results for the same facility, the conflict is raised with the custodian at clause 1.7 and resolved against the Code, not by preference.

1.6.1 Where a companion product and these Guidelines address the same matter, the product named in the routing table governs and these Guidelines are read with it. A conflict between products shall be recorded and referred to the custodian; it shall not be resolved silently on a project.

1.7 Custodianship, endorsement and revision

1.7.1 These Guidelines are held jointly by the Pakistan Engineering Council and the National Disaster Risk Management Fund: the Pakistan Engineering Council as technical custodian for the practicing design profession, and the National Disaster Risk Management Fund as custodian for financed works. The custodians maintain the controlled text, receive clarification requests and conflict referrals using the format at Annex B, and authorize revision.

1.7.2 Institutional endorsement is sought through the Pakistan Engineering Council as a code companion for the practicing design profession, and through the National Disaster Risk Management Fund as an eligibility and appraisal reference for financed school and health-

facility works. Endorsement by either institution does not transfer the design responsibility that these Guidelines place on the competent engineer.

Table 1.6 Endorsement and revision route

Step	Action	Responsible
1	Technical acceptance of the controlled text	KnK Japan, CD-CRI programme
2	Endorsement as a code companion for the practicing design profession	Custodian
3	Adoption as an appraisal and eligibility reference for financed works	Custodian
4	Publication of the endorsed edition with an issue number and date	Custodian
5	Registration of clarifications and deviations received from projects	Custodian, using Annex B."

1.7.3 These Guidelines are reviewed on a three-year cycle. A revision is triggered before that cycle by any of the following: a new edition or amendment of the Building Code of Pakistan or of a standard it references; publication of a national climate projection by the competent national authority; a change in the environmental screening regime at clause 2.4; a clarification or deviation register entry that discloses an error or a systematic misapplication; or a written direction of the custodian.

1.7.4 Adoption is measured for programme reporting as the number of school and health-facility design packages whose design basis report at clause 4.3 records these Guidelines as adopted, and whose Design Compliance Certificate at Chapter 15 is signed. A facility counts once, at design certification.

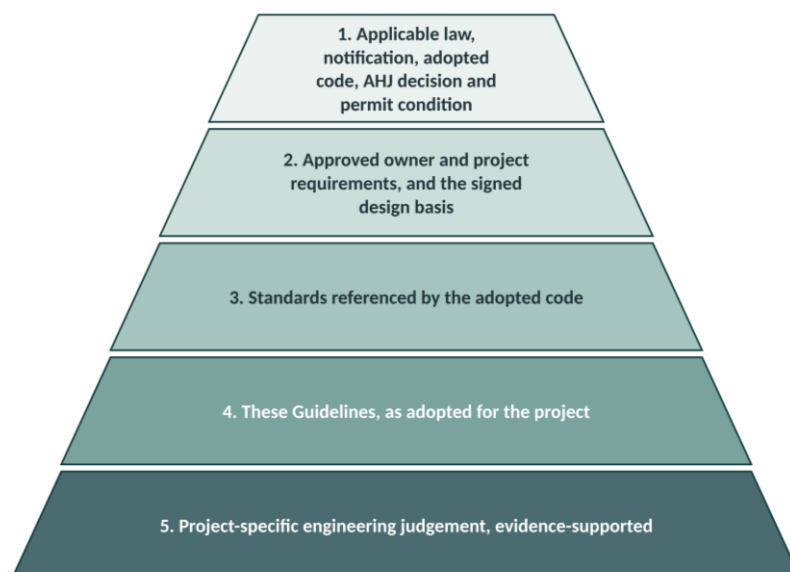
2 Governance, Code Basis and Design Control

2.1 Governing hierarchy

The project shall identify the Authority Having Jurisdiction (AHJ), the code edition in force, local amendments, permit conditions and owner requirements before design criteria are fixed. Where two applicable requirements conflict, the conflict is recorded and resolved by the competent authority; it is not settled silently by selecting one. The governing order is summarized in Figure 2.1.

Table 2.1 Governing hierarchy of requirements

Priority	Controlling material
1	Applicable law, notification, adopted code, AHJ decision and permit condition
2	Approved owner and project requirements, and the signed design basis
3	Standards referenced by the adopted code, in the edition referenced
4	These Guidelines, as adopted for the project
5	Project-specific engineering judgement supported by evidence and review



Strict precedence: a lower tier cannot override a higher one

Figure 2.1 Governing hierarchy of requirements

2.2 Code basis

These Guidelines adopt the Building Code of Pakistan 2021 (BCP-2021) as their baseline code basis. For each project, the governing code shall also reflect the applicable law, the code edition and amendments in force, permit conditions and the decisions of the AHJ identified under Section 2.1. Any difference between the baseline basis of these Guidelines and the project-specific governing basis shall be recorded and resolved before design criteria are fixed. BCP-2021 is an International Building Code derivative and uses that numbering: Chapters 1 to 34 followed by Appendices A, B and C. The provisions relied upon in these Guidelines are listed below.

Table 2.2 Code basis provisions applied by these Guidelines

Subject	Provision
Risk Category	§1604.5 and Table 1604.5
Load combinations and structural design	Chapter 16
Basic design wind speed	§1609.3
Flood loads and flood hazard areas	§1612, and Appendix B
Mapped earthquake acceleration parameters	§1613.2.1, Figures 1613.2.1(1) and 1613.2.1(2), and Appendix C
Concrete	Chapter 19
Masonry	Chapter 21
Seismic evaluation and retrofit of existing buildings	Appendix A
Fire and life safety	Building Code of Pakistan, Fire Safety Provisions 2016

2.3 Evidence classes

Design values carry different weight according to their provenance. The class of each value relied upon is recorded so that a reviewer can judge it.

Table 2.3 Evidence classes and their permitted use

Class	Examples	Permitted use
Governing source	Adopted code, gazette notification, AHJ decision, signed owner requirement	Mandatory project basis within its scope.
Authoritative technical source	Published standard, government dataset, peer-reviewed publication	Design method or value where applicable and correctly interpreted.
Project evidence	Survey, laboratory result, model, calculation, inspection or monitoring record	Project-specific decision support after checking and review.
Secondary guidance	Training material, summary, explanatory article	Context and workflow only; not the sole basis for design value.

2.4 Environmental screening pathway

A school or health-facility project is subject to a statutory environmental screening regime. The screening determination is a governing requirement under clause 2.1 and is fixed before design criteria are closed, not after.

2.4.1 The applicable instruments are the Pakistan Environmental Protection Act 1997 as applied in the Islamabad Capital Territory, and the corresponding provincial Acts: the Khyber Pakhtunkhwa Environmental Protection Act 2014, the Punjab Environmental Protection Act 1997 as amended, the Sindh Environmental Protection Act 2014, the Balochistan Environmental Protection Act 2012, and the instruments in force in Gilgit-Baltistan and Azad Jammu and Kashmir. Screening categories and thresholds are set by the Pakistan

Environmental Protection Agency Review of IEE and EIA Regulations 2000, Schedules I and II, as adopted or amended by the province.

Table 2.4 Environmental screening pathway and its entry into the design basis

Step	Question	Determined by	Output and where it is recorded
1	Which Act and regulations apply to the site and the executing agency?	Design lead, confirmed with the provincial EPA	Applicable instrument and edition, recorded in the design basis report at clause 4.3.
2	Does the project fall in Schedule I (IEE), Schedule II (EIA), or below both?	Provincial Environmental Protection Agency, on the proponent's submission	Written screening determination. A determination made by the designer alone is not a determination.
3	Where an IEE or EIA is required, what mitigation and monitoring is imposed?	Provincial EPA approval conditions	Approval conditions carried into the design basis report and the specification, and registered at clause 15.2.
4	Do the approval conditions conflict with a resilience or clinical requirement?	Design lead with the owner and AHJ	Conflict resolved and recorded under clause 12.4; not settled by preferring one requirement silently.
5	How is the screening evidenced for the programme?	Design lead	CD-CRI Environmental Inspection and Audit Format, and the digital SHA and environmental screening tool identified at clause 1.6.

2.4.2 Where the screening determination has not been obtained, the design basis report shall record that fact as an open governing requirement. Design may proceed, but the Design Compliance Certificate at Chapter 15 shall not be signed while the determination is outstanding.

2.4.3 These Guidelines are applied consistently with the National Adaptation Plan of Pakistan 2023. The Plan sets national adaptation priorities and does not set design values; where a project is financed against an adaptation commitment traceable to the Plan, the commitment is recorded as an owner requirement under clause 2.1 and the design values remain those established under Chapter 3.

2.5 Proportionality and application tiers

The evidence these Guidelines require is set in proportion to what is at risk. A single high-evidence route applied to every facility produces non-compliance rather than partial compliance because the modelling and standards require paid access and are not available in every district. The tiers below state the minimum that is acceptable at each level of exposure. They reduce the evidence set; they do not reduce the design obligation, and they do not authorize an unsafe design.

Table 2.5 Application tiers, minimum evidence and review level

Tier	Applies to	Minimum evidence set	Review level
Tier 1 Basic	Risk Category II facilities, single storey, no material hazard exposure identified at	Site screen and photographic record; published mapped hazard parameters read at verified coordinates; drainage	Check by a second competent engineer within the design

Tier	Applies to	Minimum evidence set	Review level
	the site screen of clause 5.3, and no intervention affecting the lateral system.	and levels survey; code-compliant detailing; durability by exposure class under Chapter 10; heat measures under clause 11.3 and clause 10.4.	organization. Independent external review not required.
Tier 2 Standard	Risk Category II facilities of two or more storeys; any facility with one material hazard identified at the site screen; any retrofit affecting the lateral system or the load path.	Tier 1, plus a competent ground model for the site; a stated design flood level with its source, datum and limitation; calculation of the governing hazard actions; condition assessment where the facility exists; and the compound-condition check at clause 5.5.	Independent technical review of the governing hazard chapter and of the design basis report.
Tier 3 Full	All Risk Category III and IV facilities; all designated shelters; any facility with two or more material hazards or with a compound condition identified at clause 5.5; and any site the AHJ or the owner directs.	The full evidence route of these Guidelines as written, including calibrated hydrological and hydraulic modelling where flood governs, competent geotechnical and engineering-geology assessment where slope or ground governs, and the referenced standards in an adopted edition.	Independent technical review of the complete design, recorded at clause 15.3, and certification under clause 15.4.

- 2.5.1** The tier shall be determined and recorded in the design basis report before the design criteria are fixed, and shall be re-tested whenever the site screen, the facility classification or the intervention class changes. The tier is a recorded decision, not an assumption.
- 2.5.2** Tier 3 is mandatory and is not open to reduction for Risk Category III and IV facilities, for designated shelters, and sites exposed to two or more material hazards or compound hazard conditions. A tier shall not be lowered to fit a budget or a programme date.
- 2.5.3** Where a Tier 1 or Tier 2 project encounters a condition that the tier's evidence set cannot resolve, the design shall escalate to the higher tier and record the escalation. Proceeding on insufficient evidence is not an available option at any tier.

3 Climate Design Basis

Climate information becomes a design requirement only through a transparent chain from baseline and projection to design input, calculation, sensitivity and approval. This chapter fixes that chain. Figure 3.1 sets out the chain from baseline value to approved design basis.

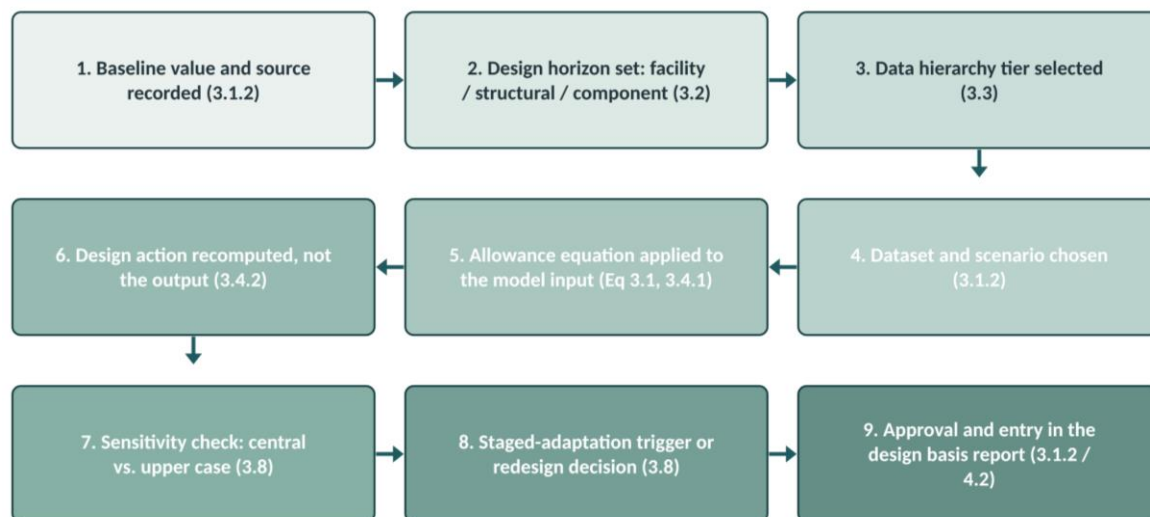


Figure 3.1 The climate design basis chain

3.1 Objective

- 3.1.1** The climate design basis shall convert climate information into explicit project decisions without presenting uncertain projections as code-mandated certainty.
- 3.1.2** Each adopted allowance shall record the affected design variable, the baseline value and its source, the spatial scale and baseline period, the design horizon, the dataset and scenario, the calculation method, the resulting value, the limitations, and the approving reviewer.
- 3.1.3** Where the available evidence does not support a defensible numerical allowance, the project shall rely on robust siting and detailing, sensitivity analysis, monitoring and staged adaptation, and shall record that no numerical allowance was adopted and why. A national default shall not be assumed in the absence of one published by the competent authority.

3.2 Design horizon

A single horizon should not be assumed for every system. The facility, the structure, the site drainage, the envelope and replaceable equipment may reasonably carry different horizons, provided their interfaces and replacement access are planned.

Table 3.1 Design horizon decisions and the evidence each requires

Decision	Question recorded	Evidence
Facility horizon	How long must the facility continue its intended public function?	Owner brief, asset plan, funding conditions.

Decision	Question recorded	Evidence
Structural horizon	What reference period governs structural and geotechnical decisions?	Adopted code and project design basis.
Component horizon	Which envelope, equipment or service components will be replaced earlier?	Service-life and maintenance plan.
Adaptation review	When can future information or further intervention be incorporated?	Monitoring plan and capital program.

3.3 Data hierarchy

The five data-source tiers used to establish climate design basis are shown in Figure 3.2.

Table 3.2 Climate data hierarchy and the control applied to each source

Priority	Source	Control
1	Value mapped or tabulated by the adopted code, or approved by the AHJ	Confirm edition, location, interpolation and applicability.
2	Observation or projection published by a competent national or provincial agency	Record station or grid, period, quality control and spatial relevance.
3	Project-specific monitored or modelled study	Retain the model, calibration, assumptions and independent review.
4	Peer-reviewed regional publication	Demonstrate transferability and quantify limitations.
5	International analogue or screening default	Sensitivity analysis only, unless formally accepted for design.

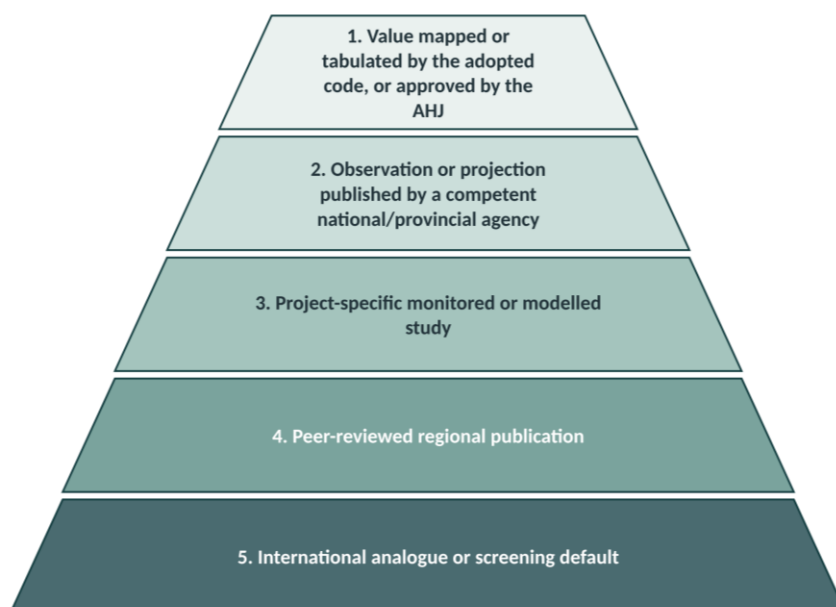


Figure 3.2 Climate data source hierarchy

3.4 Allowance method

Where an allowance is adopted for a baseline variable, it is applied as a proportional adjustment to that variable.

$$X_{design} = X_{baseline} \times (1 + \Delta X) \quad (3.1)$$

- 3.4.1** Equation (3.1) is a bookkeeping form. It is not evidence for the value of ΔX , which requires its own source and an approved derivation.
- 3.4.2** Where the relationship between the climate variable and the design action is non-linear, the allowance shall be applied to the model input and the design action recomputed. It shall not be applied to the resulting force, level or capacity unless that transformation has been demonstrated for the case in hand.

3.5 Rainfall, flow and flood level

- 3.5.1** A rainfall allowance shall not be assumed to produce an equal proportional change in peak flow. Losses, storage, routing, antecedent conditions, catchment change and drainage capacity all alter the response, and the change in flow shall be obtained by running the catchment model with the adjusted rainfall input.

The design flood level shall be assembled from mutually exclusive terms on a common vertical datum, each with its own source and method. The climate-driven model effect is the change in modelled water level obtained by rerunning the governing hydrological or hydraulic model with the approved climate-adjusted input. A separate coastal allowance is included only where that effect is not already represented in the governing model.

$$DFL = \text{baseline flood level} + \Delta h_{climate} + h_{coastal, additional} \quad (3.2)$$

- 3.5.2** Equation (3.2) does not permit the addition of a generic percentage or level increment to a mapped or modelled flood level. Terms already represented in the governing hydrological, hydraulic or coastal model shall not be added again; where a coastal process is fully integrated into one joint model, the additional coastal term is recorded as zero so that the non-double-counting decision is explicit. All level terms shall use the same vertical datum. Where no competent model exists for the site, the absence shall be recorded as a design-basis deficiency and resolved before the design flood level is fixed.

3.6 Heat

- 3.6.1** Future heat exposure shall be assessed where occupant health, learning, clinical function, equipment, medicines, the cold chain, power demand or material performance may be affected. A threshold expressed as days above a temperature shall identify the dataset, the temperature metric, the baseline period, the horizon and the spatial resolution.
- 3.6.2** The threshold required at clause 3.6.1 shall be stated as an indoor operative-temperature limit for each critical space, with the hours or proportion of occupied time for which exceedance is accepted, and as a passive-survivability duration for the spaces identified at clause 10.4.2.

Where the owner or the AHJ has not set a value, the adoptable defaults at Table 10.4 shall be applied and recorded as adopted.

3.7 Hazards without a proportional climate adjustment

Table 3.3 Hazards for which no proportional climate adjustment is prescribed

Hazard	Position	Required response
Earthquake ground motion	No climate adjustment applies to the seismic hazard.	Use the mapped parameters of BCP-2021 §1613.2.1; examine climate interactions such as scour, saturation, corrosion and post-event fire.
Extreme wind	These Guidelines prescribe no national climate multiplier on wind speed.	Use the governing basis of BCP-2021 §1609.3, and site-specific evidence where cyclone or topographic effects are material.
Slope instability	No single multiplier is applicable.	Analyze rainfall, groundwater, drainage, erosion and land-use scenarios through the geotechnical model.
Deterioration	No universal proportional increase applies.	Use exposure classification, service life and maintenance scenarios (Chapter 10).
Fire	No direct load multiplier applies.	Assess heat, drought, power-system and post-disaster ignition and response interactions.

3.8 Sensitivity and staged adaptation

Figure 3.3 summarizes the sensitivity and staged-adaptation decision matrix.

Table 3.4 Decision routes following sensitivity testing

Decision type	Central case satisfied	Central satisfied, upper case not	Neither satisfied
Fixed, long-life element	Adopt and record	Design for the upper case	Redesign or relocate
Replaceable component	Adopt and monitor	Stage the upgrade against a trigger	Upgrade now
Site or access dependency	Maintain surveillance	Protect or provide redundancy	Avoid or relocate
High data uncertainty	Close the critical gaps	Adopt low-regret measures	Do not proceed without resolution

	Central case satisfied	Central satisfied, upper case not	Neither satisfied
Fixed, long-life element	Adopt and record	Design for the upper case	Redesign or relocate
Replaceable component	Adopt and monitor	Stage the upgrade against a trigger	Upgrade now
Site or access dependency	Maintain surveillance	Protect or provide redundancy	Avoid or relocate
High data uncertainty	Close the critical gaps	Adopt low-regret measures	Do not proceed without resolution

Figure 3.3 Sensitivity and staged adaptation decision matrix

3.8.1 A staged adaptation plan shall state the monitored variable, the baseline, the trigger value, the responsible owner, the inspection frequency, the intervention, the lead time, the budget route and the consequence if the trigger is missed. Figure 3.4 illustrates the adjustment and the staged adaptation trigger over the service life.

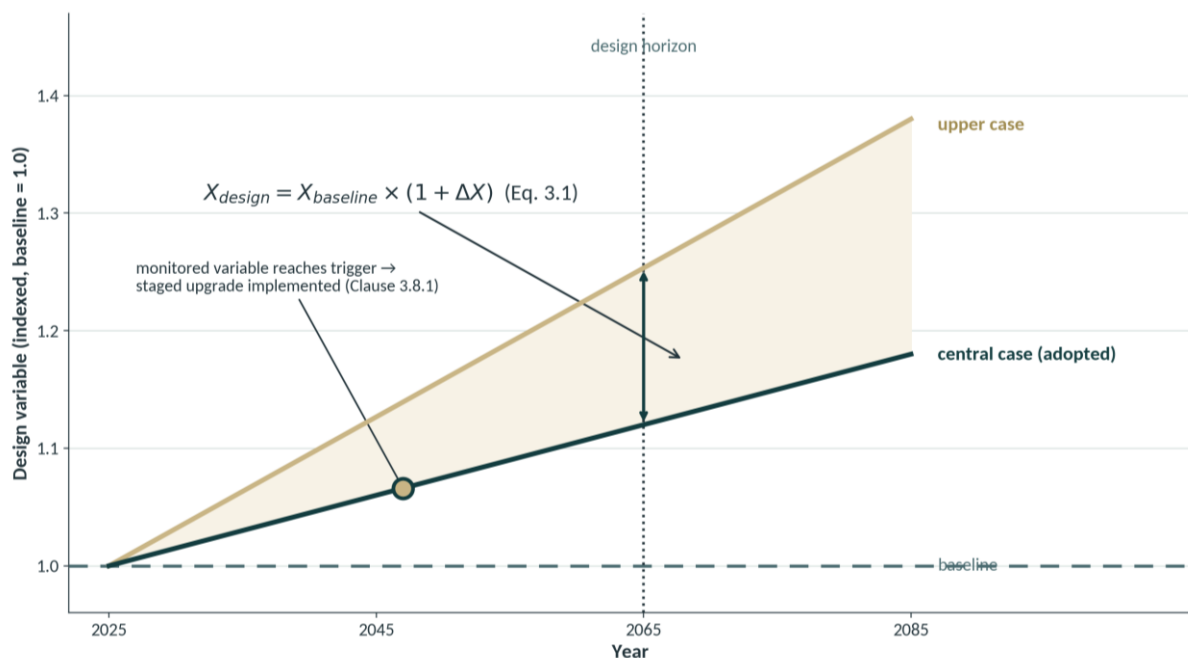


Figure 3.4 Climate adjustment and staged adaptation of a design variable

4 Project Workflow and Design Stages

4.1 Entry

4.1.1 Design shall begin from a recorded entry position: the facility identity, the condition of the existing building where one is present, the scope of the proposed works, the hazard history and the decisions already taken.

Where the project concerns an existing building, the structural condition and adequacy of that building are established by assessment before intervention is designed. Where the project is new construction on a new site, Chapter 5 governs the first decision.

4.2 Delivery stages and gates

The ten stages and their gates are shown in Figure 4.1.

Table 4.1 Design and delivery stages

Stage	Decision gate	Retained evidence
1. Mandate	Is the brief, the authority and the intended function clear?	Owner brief, facility identity, budget and program assumptions, decision authorities.
2. Applicability	Which code, hazards and approvals apply?	Applicability and routing record.
3. Data	Is the evidence sufficient for the decisions ahead?	Survey, investigation, source and limitations register.
4. Design basis	Are the baseline, climate cases, site model and objectives accepted?	Approved design basis report.
5. Options	Do the options address every material hazard and service requirement?	Option comparison, residual risk, owner decision.
6. Developed design	Are calculations, details, specifications and interfaces complete?	Checked design package and compliance matrix.
7. Review	Are technical and institutional comments closed?	Review register and signed closure.
8. Construction	Does the installed work match the approved design?	Submittals, inspections, tests, non-conformance records, as-built drawings.
9. Handover	Are systems commissioned and operators prepared?	Commissioning records, training, operation and maintenance manual, certificate.
10. Operation	Is performance maintained and are triggers monitored?	Inspection, maintenance, monitoring and update records.

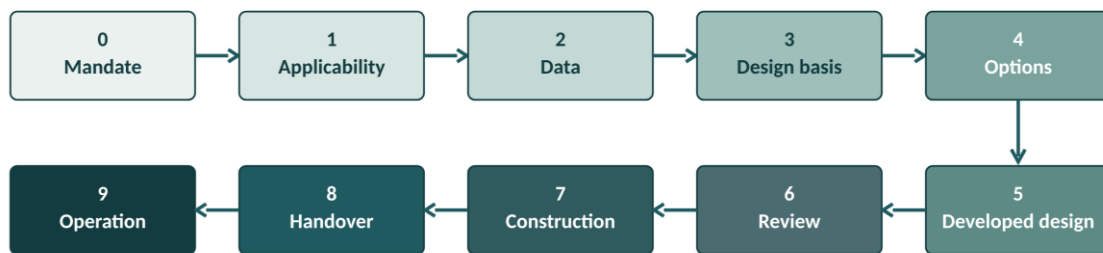


Figure 4.1 Delivery stages and gates

4.3 Design basis report

4.3.1 A design basis report shall be issued before detailed design and updated at every material change. It shall be concise enough to be used as a control document and complete enough for an independent reviewer to reconstruct the decisions.

Table 4.2 Design basis report contents

Section	Content
1. Asset and mandate	Facility, blocks, location, owner, intended use, service requirement, project scope.
2. Governance	AHJ, code and edition, approvals, owner requirements, responsible parties.
3. Existing evidence	Condition and adequacy findings, surveys, drawings, tests, data quality and gaps.
4. Hazards and site	Hazard mechanisms, site model, exclusions, access and dependencies.
5. Climate basis	Horizon, baseline, projection, scenario, allowances and uncertainty.
6. Performance objectives	Life safety, functionality, continuity and recovery targets.
7. Design methods	Analysis routes, load combinations, models, acceptance criteria, software and version.
8. Options and decisions	Alternatives, selection basis, cost and disruption, residual risk.
9. Verification plan	Calculations, drawings, review, tests, inspections and hold points.
10. Change record	Revisions, approvals and closure status.

4.4 Responsibility

Table 4.3 Responsibility for each design decision

Decision	Prepared by	Checked by	Accepted by
Applicability and routing	Design lead	Program technical lead	Owner, AHJ as applicable
Climate design basis	Climate or hazard specialist	Design lead and independent reviewer	Owner; AHJ where required
Structural criteria and calculations	PEC-registered structural engineer	Independent checker	Responsible signatory; AHJ

Decision	Prepared by	Checked by	Accepted by
Geotechnical and hydrological basis	Competent discipline specialist	Independent discipline reviewer	Design Lead; AHJ
Intervention and residual risk	Multidisciplinary design team	Technical lead	Owner or funder; AHJ

4.5 Consent, safeguarding and personal data

These Guidelines commission site photography, occupancy data and facility records at Chapters 4 and 5, and those activities take place at facilities occupied by children and by patients. The provisions below apply to every stage at which such material is collected, held or published.

- 4.5.1** Photography, video, occupancy data and facility records shall be collected only with the informed consent of the responsible authority for the facility and, where an identifiable individual is recorded, of that individual or of the parent or guardian of a child. Consent shall be recorded in writing and retained with the project record.
- 4.5.2** Children shall not be identifiable in any published output. Names, class lists, admission or patient records, uniforms carrying a facility name, signage identifying a facility, and precise coordinates of an occupied facility shall not be published. Where a facility is named in a published output, no identifiable image of a child shall accompany it.
- 4.5.3** Every person carrying out a site visit under these Guidelines shall conduct themselves so as to protect children and patients from harm, and shall not engage in any form of sexual exploitation, abuse or harassment. A site visit to an occupied school or health facility shall be arranged through the responsible authority and shall not place a visitor alone with a child.
- 4.5.4** Personal data collected for the design shall be limited to what the design requires, held securely, and retained only for the period stated in the project record.

5 Siting, Multi-Hazard Planning and Compound Risk

Siting is the first and most consequential resilience decision. Structural strengthening cannot compensate for an unexamined site, a facility that cannot be reached, or a mitigation measure that transfers risk to someone else.

5.1 Siting decisions

- 5.1.1** For new construction or relocation, the design team shall demonstrate that reasonable site alternatives were compared before the design fixed the project on a materially avoidable hazard exposure.
- 5.1.2** For an existing facility, the site review shall distinguish risks that can be managed in place from risks that require relocation, functional transfer or a redundant service route.
- 5.1.3** Site acceptability shall be judged for the facility and for the service network. A building that remains standing but loses access, power, water, drainage, communications or staff reach has still failed its public function.

5.2 Minimum site evidence

Figure 5.1 shows how the groups below appear on an actual plan.

Table 5.1 Minimum site evidence by group

Group	Questions	Record
Location and boundaries	Are coordinates, levels, boundaries, easements and adjacent uses verified?	Survey control, base map, ownership and constraint record.
Terrain and drainage	Where does water enter, pond, flow and leave under ordinary and extreme conditions?	Topographic survey, catchment delineation, outfalls, observed flood marks.
Ground and slopes	What materials, groundwater, fills, cuts and unstable features are present?	Geotechnical desk study, investigation, geomorphological record.
Hazard history	What has happened at and around the site?	Agency records, imagery, community and operational accounts with dates.
Access and lifelines	Can occupants, emergency services and supplies reach the facility during the design event?	Route levels, crossings, utility dependencies and alternatives.
Environmental and social	Are drainage, ecology, heritage, inclusion and neighboring communities affected?	Screening, approvals and mitigation register.



Figure 5.1 Site evidence read on an example plan

5.3 Avoidance and escalation

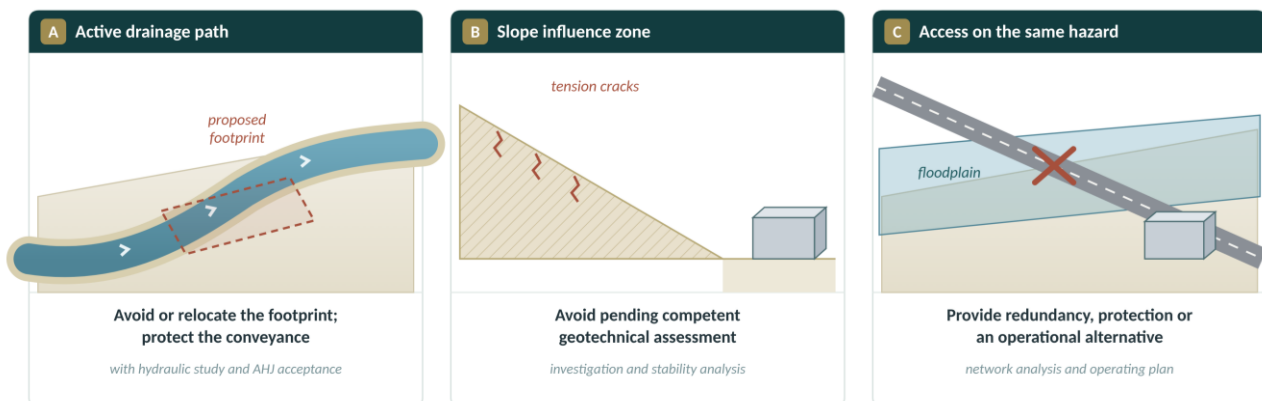
Figure 5.2 presents the screen with its default responses and the evidence required to vary them. Figure 5.3 illustrates three conditions that commonly trigger it.

Table 5.2 Site avoidance and escalation screen

Condition	Default planning response	Evidence required to vary it
Active floodway, hill torrent or concentrated drainage path	Avoid or relocate the building footprint; protect the conveyance.	Hydrological and hydraulic study, AHJ acceptance, demonstrated safe access.
Slope influence zone, unstable or potentially unstable	Avoid pending competent geotechnical assessment.	Investigation, stability analysis, drainage design and monitored mitigation with independent review.
Uncontrolled fill, collapsible soil, liquefaction susceptibility or active erosion	Investigate and treat before foundations are fixed.	Ground model, ground-improvement or foundation design, and a verification plan.
Coastal erosion, surge or sea-level exposure	Compare retreat or relocation against a protected-site option.	Coastal process study, horizon and scenario, lifecycle maintenance plan.
A single access or utility route exposed to the same hazard as the facility	Provide redundancy, protection or an operational alternative.	Network analysis and emergency operating plan.
Mitigation that transfers risk off site	Do not proceed until the transferred risk is evaluated and accepted.	Upstream, downstream, neighbour and environmental impact analysis.

Site condition screen (Table 21)		
Condition found on site	Default planning response	Evidence required to vary
Active floodway, hill torrent or concentrated drainage path	Avoid or relocate footprint; protect the conveyance	Hydrological / hydraulic study, AHJ acceptance, safe access
Slope influence zone, unstable or potentially unstable	Avoid pending competent geotechnical assessment	Investigation, stability analysis, drainage, monitored mitigation
Uncontrolled fill, collapsible soil, liquefaction or active erosion	Investigate and treat before foundations are fixed	Ground model, ground improvement or foundation design, verification
Coastal erosion, surge or sea-level exposure	Compare retreat or relocation vs. protected-site option	Coastal process study, horizon and scenario, maintenance plan
Single access or utility route sharing the facility's hazard exposure	Provide redundancy, protection or operational alternative	Network analysis, emergency operating plan
Mitigation that transfers risk off site	Do not proceed until transferred risk is evaluated and accepted	Upstream, downstream and neighbour impact analysis

Figure 5.2 Avoidance and escalation screen



Illustrative conditions, not project records. Fixed universal setbacks are screening prompts, not design criteria.

Figure 5.3 Conditions that trigger avoidance or escalation

5.3.1 The site screen shall test expressly for glacial lake outburst flood, debris flow and hyperconcentrated flow exposure wherever the site lies within a valley draining a glaciated catchment, downstream of a moraine- or ice-dammed lake, on or adjacent to an alluvial fan, or on a channel with a recorded history of debris transport. Where any of these conditions is present, the default planning response is avoidance or relocation of the building footprint, and the condition shall be referred for specialist assessment under clause 1.2.2. The screen result, the referral and the assessment outcome shall be recorded in the design basis report at clause 4.3, and the facility shall be treated as Tier 3 under clause 2.5.

5.3.2 Where the screen at cl. 5.3.1 identifies glacial lake outburst flood, debris flow or hyperconcentrated flow exposure and avoidance or relocation of the building footprint is demonstrably not possible, the facility shall not be designed against values assumed by the

designer. A specialist assessment shall establish the credible event, the flow depth, velocity, sediment concentration and deposition depth at the site, and the impact and buoyancy actions arising from them, and shall state its own limitations. Those parameters are the design actions, and they enter the design basis report at cl. 4.3 as governing requirements under cl. 2.1. The facility is Tier 3 under cl. 2.5, the design is independently reviewed under cl. 15.3, and the residual risk of exceedance is recorded under cl. 15.5 with a named acceptance. Where no specialist assessment is available, the site shall be rejected; a facility shall not be designed on an assumed debris-flow action.

5.4 Multi-hazard site model

Each hazard is assessed against each system on which the facility depends, so that no interaction is left unexamined. Figure 5.4 presents the site and system interaction model.

Table 5.3 Hazard and system interaction model

System	Seismic	Flood	Wind	Slope	Deterioration	Fire
Ground and foundation	Shaking, liquefaction	Scour, saturation	Overturning	Movement	Aggressive exposure	Post-fire condition
Building envelope	Drift damage	Inundation	Pressure, debris	Impact	Moisture, heat	Compartment breach
Access	Debris, bridge damage	Cut-off	Fallen trees and debris	Blockage	Progressive loss	Evacuation and emergency reach
Power, water, data	Anchorage, outage	Submergence	Line damage	Route rupture	Corrosion	Emergency isolation
Campus drainage	Joint damage	Capacity exceedance	Wind-driven rain	Erosion	Leakage	Fire-water runoff

	Ground and foundation	Building envelope	Access	Power, water, data	Campus drainage
Seismic	Shaking, liquefaction	Drift damage	Debris, bridge damage	Anchorage, outage	Joint damage
Flood	Scour, saturation	Inundation	Cut-off	Submergence	Capacity exceedance
Wind	Overturning	Pressure, debris	Fallen trees and debris	Line damage	Wind-driven rain
Slope	Movement	Impact	Blockage	Route rupture	Erosion
Deterioration	Aggressive exposure	Moisture, heat	Progressive loss	Corrosion	Leakage
Fire	Post-fire condition	Compartment breach	Evacuation and emergency reach	Emergency isolation	Fire-water runoff

A cell left blank means reviewed and not material, not unreviewed (Clause 5.4.1)

Figure 5.4 Multi-hazard site model

5.4.1 Each material cell shall be assigned an owner, an evidence source and a design or operational response. No material cell shall be left blank. Where an interaction has been reviewed and found not material, the cell shall state, "Not material" and record the basis for that conclusion. Where the position is not yet settled, the cell shall state, "Clarification required".

5.5 Compound and cascading conditions

Figure 5.5 sets out two representative sequences in which the second event meets a facility already degraded by the first.

Table 5.4 Compound and cascading design cases

Sequence or combination	Why independent checks are insufficient	Response
Flood or scour followed by earthquake	Foundation support and stiffness may already be degraded when seismic demand arrives.	Assess the credible degraded foundation state; provide inspection and closure triggers.
Earthquake followed by fire	Damaged suppression, gas and electrical systems and obstructed egress raise fire consequence.	Coordinate restraint, isolation, compartmentation and the emergency plan.
Extreme rainfall with slope movement	Drainage blockage and saturated materials can change the failure mechanism.	Analyse saturated and drain-blocked cases; maintain access to drainage.
Extreme heat with power outage	Mechanical cooling, cold chain and clinical equipment can fail together.	Passive survivability, backup supply and operational thresholds.

Sequence or combination	Why independent checks are insufficient	Response
Wind with wind-driven rain	An envelope breach changes internal pressure and admits water simultaneously.	Continuous load path, opening protection, drainage and containment.
Deterioration preceding any hazard event	Reduced section, bond or connection capacity changes the response to the event.	Use the assessed current condition and the planned future condition.

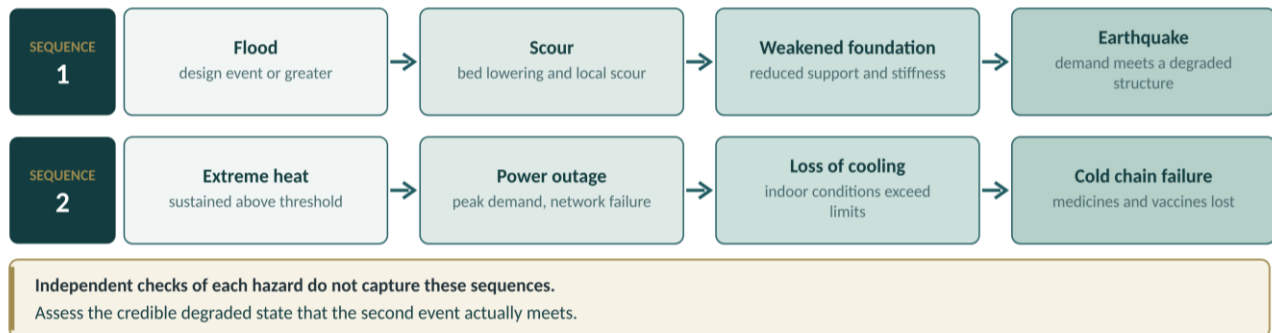


Figure 5.5 Representative compound and cascading sequences

5.6 Nature-based and hybrid measures

5.6.1 Nature-based measures may reduce runoff, erosion, heat and exposure. They shall be designed as systems, with land take, establishment period, maintenance regime, exceedance path and failure behavior defined.

5.6.2 A nature-based measure shall not be credited with structural or life-safety capacity that has not been demonstrated for the project.

Table 5.5 Nature-based and hybrid measures and their interface checks

Measure	Function	Interface check
Vegetated swale or detention landscape	Slow, store and treat runoff	Overflow route, public-health control, infiltration behavior, maintenance access.
Permeable surface	Reduce frequent-event runoff and surface heat	Subgrade, clogging, contaminants, accessible routes, extreme-event bypass.
Slope vegetation and bioengineering	Surface erosion control and shallow reinforcement	Deep-seated stability unaffected; species, establishment, fire and drainage.
Shade planting	Reduce heat exposure and improve outdoor comfort	Windfall, roots, utilities, visibility, safeguarding, irrigation demand.

6 Seismic Design Criteria

6.1 Controlling basis

- 6.1.1** Seismic demand, analysis, detailing and acceptance shall follow the adopted code and the standards it references. These Guidelines add resilience and continuity interfaces; they do not replace structural calculation.
- 6.1.2** Mapped parameters shall be read from BCP-2021 Figures 1613.2.1(1) and 1613.2.1(2) at verified site coordinates, together with Appendix C, and combined with the project ground model. A district lookup shall not be attributed to the Code, which provides maps.
- 6.1.3** Existing buildings shall be evaluated and retrofitted through the route of BCP-2021 Appendix A, which adopts ASCE/SEI 41-17: Tier 1 screening under §A106, Tier 2 deficiency-based evaluation and retrofit under §A107, and Tier 3 systematic evaluation under §A108.

6.2 Design basis record

Table 6.1 Seismic design basis record

Input	Recorded	Review question
Location and hazard	Coordinates, map source, parameters, interpolation, return period	Do the source and location match the asset?
Ground model	Site class, investigation, groundwater, liquefaction, slope and foundation assumptions	Are default values justified and is uncertainty tested?
Facility classification	Occupancy, Risk Category, shelter or essential function, authority decision	Do consequences and required continuity match the classification?
Structural system	Typology, material, diaphragm, lateral system, irregularities, load path	Is the assumed system actually present and buildable?
Analysis and criteria	Method, model version, load combinations, acceptance, review	Are stiffness assumptions and non-structural demands addressed?
Climate interactions	Scour, saturation, corrosion, heat, fire, access state	Could a climate mechanism degrade the seismic response?

6.3 Performance objectives

- 6.3.1** The project shall state separate objectives for occupant safety, structural damage, non-structural hazards, critical equipment, utilities, access and recovery of service.
- 6.3.2** A school or health facility shall not be assigned an enhanced performance objective by label alone. The owner, the AHJ and the engineer responsible shall record the intended post-event function and the systems required to deliver it.
- 6.3.3** Risk Category is assigned under BCP-2021 §1604.5 and Table 1604.5 as printed, and is not open to programme or project discretion. A school with an occupant load greater than 250 is Risk Category III; a facility with emergency surgery or emergency treatment capacity is Risk Category IV; and any facility designated an earthquake, hurricane or other emergency shelter

is Risk Category IV irrespective of occupancy type. The occupant-load threshold, the emergency treatment and surgery criterion and the designated shelter criterion shall be read against the printed Table 1604.5 for the project, and the assigned Risk Category and its clause citation shall be recorded in the design basis report at clause 4.3.

Figure 6.1 shows the continuous load path from roof to foundation and the points at which continuity is commonly lost.

6.4 Load path and configuration

Table 6.2 Load path and configuration controls

Control	Design intent
Vertical continuity	Avoid weak- and soft-storey mechanisms and discontinuous lateral elements
Confined masonry integrity	Provide tie-columns, tie-beams, wall panels, openings and connections as a complete system
Restraint of unreinforced masonry	Prevent out-of-plane wall, gable and parapet failure and loss of diaphragm support
Diaphragm transfer	Transfer inertia forces through collectors and chords into positive wall or frame connections
Non-structural restraint	Prevent falling or sliding components and preserve critical equipment
Separation and interaction	Address pounding, appendages and differing dynamic response



Figure 6.1 Continuous seismic load path

6.5 Typology compatibility

Table 6.3 Typology issues and their design consequences

Typology issue	Question	Design consequence
Concrete frame with masonry infill	Are infills isolated, participating, irregular or partially open?	Model strategy, column shear and short-column checks, drift compatibility.
Confined masonry	Are confining elements continuous and correctly connected?	System qualification, opening and detail review, foundation continuity.
Unreinforced masonry	How are walls tied to diaphragms and restrained out of plane?	Anchorage and confinement measures (Chapter 13).
Stone, adobe, Dhajji and other local systems	What material, connection and diaphragm behaviour are supported by evidence?	System-specific assessment and compatible intervention.
Light roof on masonry walls	Are sheeting, purlins, trusses and wall bearings positively connected?	Seismic and wind load paths coordinated.
Additions and mixed blocks	Do joints, levels and foundations create interaction?	Separate, or explicitly analyse and detail, the interface.



Figure 6.2 Confined masonry under construction: tie-columns cast against toothed panels with a continuous bond beam

6.6 Non-structural and functional resilience

Table 6.4 Non-structural and functional resilience controls

System	Minimum control
Ceilings, lights and fans	Restraint, clear load path, compatible movement, safe location over occupied and egress areas.
Storage, shelving and laboratory equipment	Anchorage, restraint of contents, safe clearances.

System	Minimum control
Water tanks and solar arrays	Support and anchorage, sloshing and movement, weatherproofed penetrations.
Medical equipment and gases	Anchorage, flexible or isolated services, shut-off, post-event inspection.
Electrical, data and backup power	Anchorage, cable and pipe movement capacity, fire isolation, restart plan.
Egress and accessibility	Doors, stairs, ramps, partitions and external routes remain usable to the stated objective.

6.7 Review checklist

- Hazard parameters, site class and geotechnical assumptions are traceable and checked.
- Facility classification and performance objectives are recorded and approved.
- Gravity and lateral load paths are continuous through connections and foundations.
- Irregularity, mixed systems, infill and diaphragm behavior are explicitly addressed.
- Non-structural components, critical equipment, egress and utilities match the service objective.
- Climate-degraded states and compound cases are included where material.
- Every detail reference is supported by calculation, drawing and inspection hold points.

7 Flood, Drainage and Scour

7.1 Mechanism and route

7.1.1 The governing flood mechanisms shall be identified separately: riverine flooding, urban or pluvial flooding, hill torrent, drainage surcharge, groundwater, embankment or dam failure where relevant, coastal level, surge and waves, and local erosion and scour. A single design flood level cannot represent mechanisms that behave differently.

7.1.2 A mapped flood extent or an observed high-water mark is evidence of a stated event, return period, datum, date and limitation. It should not be adopted as an unqualified design flood level.

Flood-resistant design is governed by BCP-2021 §1612 together with Appendix B. Section B104.1 requires development in a flood hazard area to be designed and constructed with methods, practices and materials that minimize flood damage and that accord with the Code and with ASCE 24. Where design flood elevations are not specified for the site, they are established under §1612.3.1 and §B104.3. Elevation of the lowest floor is certified under §1612.4 and inspected under §110.3.3 before further vertical construction proceeds.

7.1.3 The flood design classification, the elevation requirement and the permitted floodproofing method shall be taken from ASCE 24 in the edition adopted for the project, read together with the Risk Category assigned under §1604.5. These Guidelines do not substitute a different elevation or freeboard requirement for the one the adopted standard prescribes. Figure 7.1 sets out the route from mechanism to verified operation.

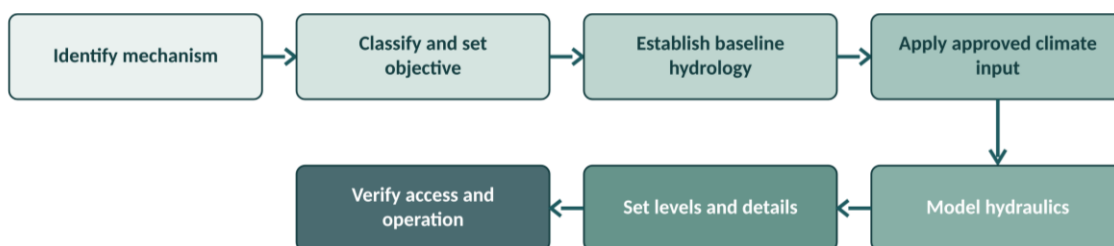


Figure 7.1 Flood design route

7.2 Design flood level

7.2.1 The design flood level shall be assembled from traceable modelled or observed terms on a common vertical datum, in accordance with Equation (3.2), each term carrying its own source and review. A surveyed high-water mark of the kind shown in Figure 7.2 is admissible evidence for the design flood level basis.



Figure 7.2 High-water mark after flood recession, one basis for the design flood level

Table 7.1 Design flood level inputs and minimum quality control

Input	Minimum quality control
Topography, floor and road levels	Survey datum, benchmark, date and accuracy.
Rainfall and flow	Station or grid, duration, return period, climate treatment, catchment change.
Catchment and drainage	Area, land cover, losses, storage, structures, blockage assumption, outfall condition.
Hydraulic model	Geometry, roughness, boundary conditions, calibration and validation, sensitivity, version.
Coastal inputs	Tide, surge, waves, sea-level change, subsidence and joint occurrence.
Observed events	Date, source, mark reliability, breach and blockage context, recurrence estimate.

7.3 Campus drainage

7.3.1 Campus drainage shall be designed as a connected source-path-receptor system with a safe exceedance route. Inlet capacity alone does not demonstrate that water can reach, pass through and discharge from the system without creating a new hazard. Figure 7.3 shows the system and its safe exceedance route.

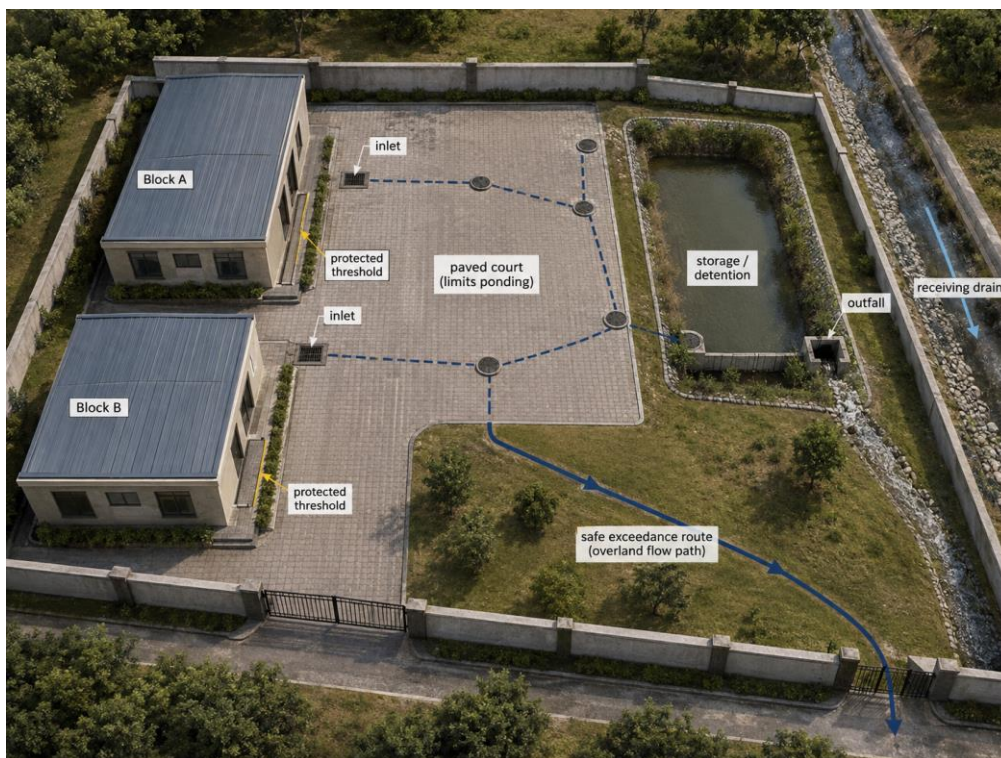


Figure 7.3 Campus drainage as a source–path–receptor system with a safe exceedance route

Table 7.2 Required drainage performance in each state

State	Roof	Ground surface	Network	Outfall	Building and access
Frequent event	Collect	Limit ponding	Convey	Free discharge	Normal operation
Design event	No unsafe ingress	Controlled routing	Capacity checked	Tailwater included	Protected threshold and access
Exceedance or blockage	Overflow path	No trapped courtyard	Blockage assumed	Backflow controlled	Safe emergency route
Maintenance	Debris access	Erosion repaired	Clean and inspect	Protected	Roles and triggers recorded

Table 7.3 Campus drainage checks and requirements

Check	Requirement
Short-duration rainfall	Use a storm duration appropriate to the catchment response, with the approved climate input of Chapter 3.
Ponding and thresholds	Map low points, door thresholds, ramps, courtyards, basements and equipment areas.
Exceedance route	Demonstrate where water travels when design capacity or inlet capacity is exceeded.
Backwater and backflow	Include the receiving-water level; provide maintainable backflow control where needed.
Sediment and debris	Allow for hill-torrent sediment, leaves and waste, with maintainable access.
Transferred risk	Demonstrate that discharge does not worsen neighboring or downstream risk.

7.4 Scour and erosion

- 7.4.1** Scour and erosion shall be assessed from the hydraulic mechanism, the soil and the foundation configuration. Inundation depth alone does not define foundation safety.
- 7.4.2** Foundation embedment shall be determined from the computed scour condition for the design and check events, together with the geotechnical capacity required below the scoured level. A universal multiplier applied to a computed scour depth shall not be used in place of that analysis: the required embedment depends on the scour mechanism, the soil profile and the foundation type. The principal scour mechanisms, foundation exposure conditions and protection concepts are illustrated in Figure 7.4.
- 7.4.3** Where cl. 5.3.2 applies, the scour and foundation assessment shall additionally address sediment-laden and hyperconcentrated flow: the increased fluid density and consequent increase in lateral action on walls and foundations, impact from boulders and woody debris, burial and deposition against the structure and its effect on egress and drainage, and blockage of culverts, openings and the campus exceedance route required at cl. 7.3. The flow parameters shall be those established by the specialist assessment under cl. 5.3.2 and shall not be inferred from clear-water flood values.

Table 7.4 Scour and erosion mechanisms and the minimum response

Mechanism	Minimum response
General bed lowering	Establish long-term level change and the resulting foundation exposure.
Local scour at foundations and walls	Model geometry and flow concentration; design protection accordingly.
Contraction scour and channel migration	Consider reach-scale change and future channel alignment.
Erosion at outlets and overflows	Provide energy dissipation, apron and toe control, and inspection access.
Debris impact and blockage	Include the changed flow path, local velocity and maintenance implications.
Post-event condition	Define closure, inspection and reopening criteria.

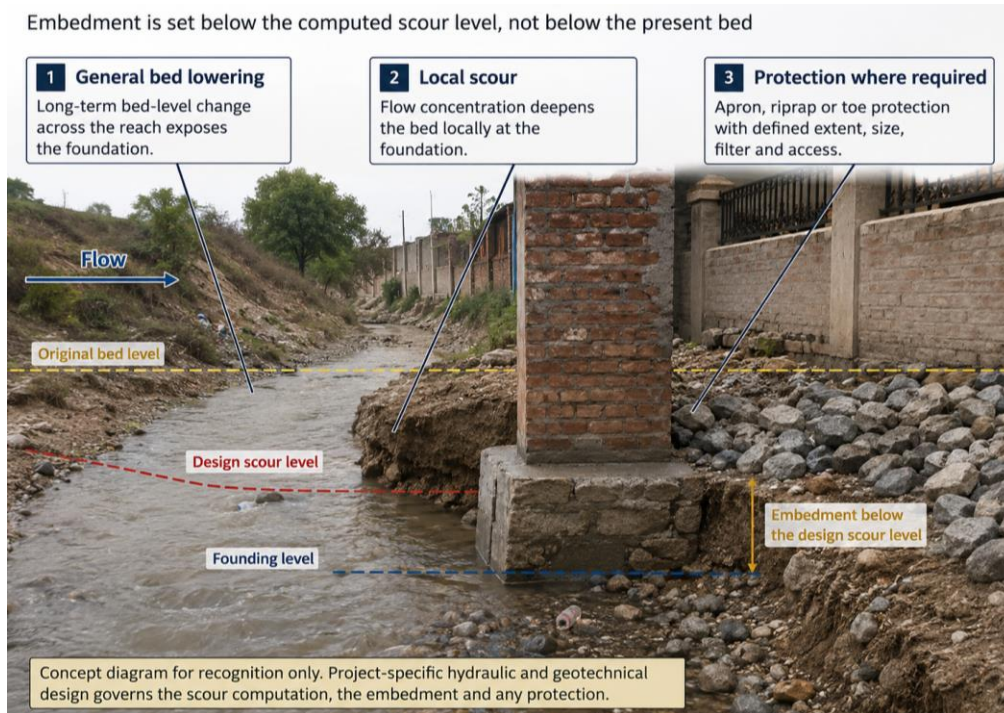


Figure 7.4 Scour mechanisms and foundation protection concept

7.5 Elevation and floodproofing

Figure 7.5 sets out the elevation and floodproofing strategies. Figure 7.6 shows how critical plant and openings are treated where those strategies are applied.

Table 7.5 Elevation and floodproofing strategies and required controls

Strategy	Application question	Required controls
Avoid or elevate	Can occupied floors and critical systems be placed above the design level?	Access and ramps, foundations, undercroft treatment, drainage, future settlement.
Wet floodproofing	Is controlled entry and exit of water compatible with the use and the structure?	Flood openings to ASCE 24, hydrostatic balance, resistant materials, cleaning and contamination control.
Dry floodproofing	Is exclusion structurally feasible and operationally reliable?	Wall and slab loads, leakage, barriers, closure time, storage, training, failure consequence.
Sacrificial zones	Can lower-level components fail without threatening safety or recovery?	Material schedule, isolation, access and reinstatement plan.
Relocate critical services	Can equipment and utilities be raised or moved?	Support, access, heat and ventilation, service routes, maintenance.



Figure 7.5 Elevation and floodproofing strategies

Keeping critical systems operable through the design flood

Elevation is the primary strategy; exclusion is only as reliable as the people who deploy it.



Figure 7.6 Elevated critical plant and a deployable barrier

7.6 Continuity and recovery

Table 7.6 Continuity and recovery requirements by system

System	Requirement
Electrical and backup power	Protect switchgear, generators, fuel, batteries and distribution; retain safe ventilation and access.
Water, sanitation and drainage	Protect supply and sewer from contamination and backflow; provide emergency sanitation continuity.
Medical gases and cold chain	Elevate or protect equipment and connections; define safe shutdown and restart.
Information systems and records	Protect equipment and data; provide continuity and recovery arrangements.
Access and evacuation	Confirm pedestrian, accessible, ambulance, supply and emergency routes.
Cleaning and reopening	Define contamination testing, drying, inspection, waste handling and authorized reopening.

7.6.1 Drainage, barriers, pumps, backflow devices, scour protection and raised services are performance systems. Their inspection frequency, responsible owner, access, spares, test method and event trigger shall be included in handover.

8 Wind Design Criteria

8.1 Design basis

The basic design wind speed is fixed by BCP-2021 §1609.3: 100 mph in the interior of Pakistan and 120 mph along the coastline. For mountainous terrain and near gorges the basic design wind speed shall be based on site-specific data determined in accordance with ASCE/SEI 7-16 Chapter 26 and approved by the Authority Having Jurisdiction. In hurricane-prone regions where the basic design wind speed is estimated from regional climatic data, it shall likewise be determined under ASCE/SEI 7-16 Chapter 26 with AHJ approval. Conversion to allowable stress design wind speed, where required, follows §1609.3.1.

- 8.1.1** The wind design basis shall record the basic design wind speed and its source, the risk and importance basis, directionality, exposure and terrain category, topographic effects, enclosure classification, internal pressure, component and cladding zones, and serviceability criteria.
- 8.1.2** A screening exposure band is not a design wind speed and shall not be used to reduce the governing design action. Figure 8.1 shows the two wind speed regions schematically.



Figure 8.1 Basic design wind speed regions (schematic; design values per BCP-2021 §1609.3)

Table 8.1 Wind design inputs and common errors

Input	Required evidence	Common error
Basic wind speed	BCP-2021 §1609.3, or a site-specific determination approved by the AHJ	Adopting an unverified map or a screening band.
Risk and importance	Facility classification and service objective	Treating all schools and health facilities alike without an authority decision.
Exposure and topography	Site survey, surroundings, hills and ridges, and the assumed surrounding development at maturity	Selecting exposure from a photograph without fetch and topography review.
Enclosure and internal pressure	Opening size, protection, doors and windows, failure scenario	Assuming an enclosed building after a dominant opening can fail.
Components and cladding	Zone pressures, tributary areas, local coefficients	Applying main-system pressures to edge and corner fasteners.
Serviceability	Deflection, vibration, water entry, critical-equipment criteria	Checking strength only.

8.2 Continuous load path

- 8.2.1** Every connection in the load path shall be checked for the governing force and failure mode, including pull-over, pull-out, bolt and anchor action, local member failure, bearing, splitting, corrosion and substrate capacity.
- 8.2.2** The capacity of a stronger new roof sheet or truss shall not be credited unless the existing supporting walls, anchors and foundations can transfer the increased action. Figure 8.2 shows the edge-initiated sheet loss that a complete load path prevents. Figure 8.3 shows the uplift load path from sheeting to foundation.



Figure 8.2 Wind loss of profiled roof sheets initiating at the roof edge

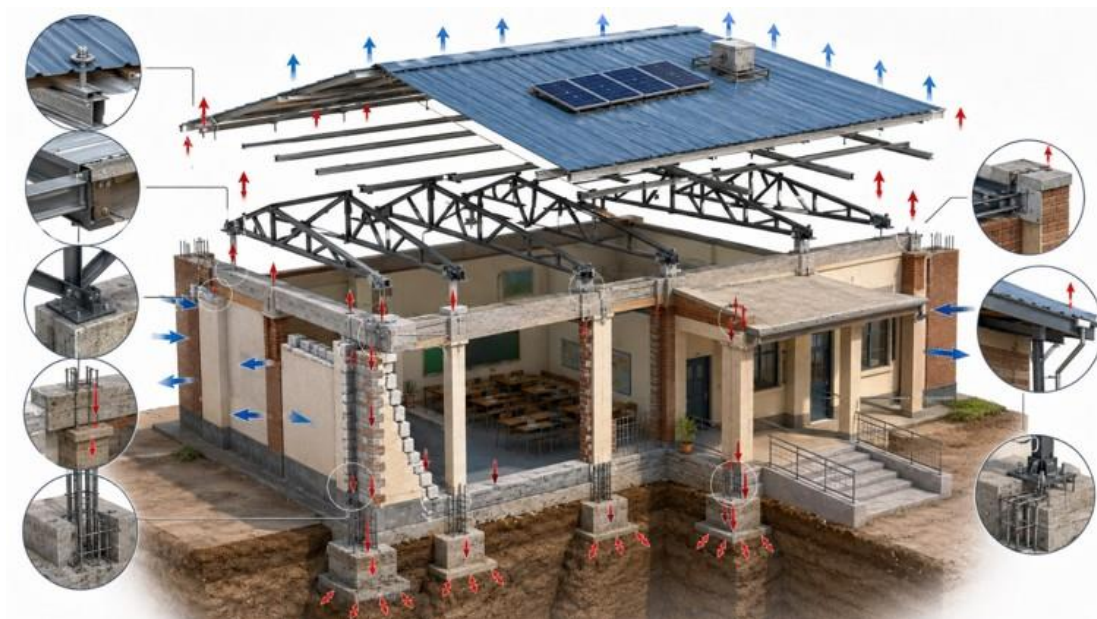


Figure 8.3 Wind uplift and lateral load path

8.3 Roofs, envelope and openings

Table 8.2 Roof, envelope and opening controls

Component	Controls
Light metal roof	Profile-specific fasteners and washers; edge and corner zone spacing; purlin capacity; laps, ridge and eave details; corrosion protection.
Tiled or heavy roof elements	Positive restraint, underlay and water control, edge zones, falling-object risk.
Parapets, gables and appendages	Out-of-plane demand, bracing and anchorage, weatherproofing, safe failure consequence.
Doors and windows	Frame and substrate anchorage, hardware, glazing or shutters where required, operability for egress.
Louvres and vents	Pressure, debris, rain entry, screens, continuity of critical ventilation.
Solar arrays, tanks and rooftop plant	Support and anchorage, aerodynamic effects, waterproofing, access, falling-object exclusion.

8.3.1 Fastener placement relative to the crown or valley of a profiled sheet is product- and system-specific. The approved manufacturer or system detail, together with the project calculation, governs; a single geometry shall not be prescribed for every profile.

8.4 Internal pressure and water entry

8.4.1 The design shall assess the sequence in which an opening, cladding zone or roof component may fail and change internal pressure or admit water. The assumed enclosure state shall match the strength and protection actually provided to the openings.

8.4.2 Water management shall provide drained and ventilated assemblies, flashings, laps, sills, penetration details and interior containment compatible with the design pressure and the consequence of failure.

8.5 Campus and external hazards

Table 8.3 Campus and external wind hazard controls

Item	Control
Trees and branches	Species and condition surveys, fall and strike zone, maintenance, shelter and evacuation routes.
Signs, tanks, towers and boundary elements	Design and anchorage, corrosion inspection, falling-object zone.
Loose materials and waste	Secure storage and a pre-event housekeeping plan.
Covered walkways and canopies	Independent wind design, load path, safe connection to buildings.
Emergency access	Debris clearance priorities, alternative route, responsible team.

9 Landslide, Slope and Ground Instability

9.1 Competent assessment

- 9.1.1** Slope and ground-instability decisions shall be based on a competent geotechnical and engineering-geology model. Surface appearance alone cannot establish the location, depth, mechanism or future movement of a landslide.
- 9.1.2** The assessment shall cover the building footprint, cut and fill slopes, retaining structures, drainage, the upslope catchment, downslope consequences, access routes and utilities.
- 9.1.3** Climate effects shall enter through rainfall, groundwater, erosion, drainage performance, vegetation, fire and weathering scenarios, and not as a single factor applied to soil strength or slope capacity. Surface indicators of the kind shown in Figure 9.1 trigger competent assessment; they do not replace it.



Figure 9.1 Head scarp and crest-parallel tension cracks above a building

9.2 Ground model

Table 9.1 Ground model components, minimum evidence and uncertainty

Component	Minimum evidence	Uncertainty to test
Geomorphology and history	Terrain, scarps, hummocky ground, drainage changes, records and imagery	Dormant or reactivated movement; events outside the observation period.
Stratigraphy and structure	Soil and rock units, fills, discontinuities, weathering, interfaces	Layer continuity, weak seams, anisotropy.
Groundwater and drainage	Levels, seepage, springs, seasonal and event response, existing drains	Blocked drainage, perched water, extreme recharge.

Component	Minimum evidence	Uncertainty to test
Geometry and loads	Surveyed slopes, cuts, fills, walls, buildings, surcharge, excavation	Future work, erosion, toe loss.
Material behavior	Sampling, testing and adopted parameters	Peak and residual strength, variability, degradation.
Failure mechanism	Kinematic and stability models linked to observation	Alternative surfaces, progressive failure.

9.3 Design cases

Table 9.2 Slope and ground instability design cases

Case	Question
Existing dry-season state	Does the model reproduce the observed condition and movement?
Seasonal high groundwater	Are pore pressures and seepage consistent with wet-season evidence?
Design rainfall with blocked drainage	What groundwater and erosion state results from the approved rainfall and drainage scenario?
Seismic condition	How do inertial demand, strength loss and deformation interact with the slope and foundation system?
Toe erosion or excavation	How sensitive is stability to removal of support or to future works?
Long-term weathering and vegetation change	How do material condition, roots, fire or lapsed maintenance alter the model?

- 9.3.1** The factor of safety, deformation limit or risk acceptance criterion adopted shall be cited to the adopted standard or the owner's requirement and reviewed against the consequence class of the facility.
- 9.3.2** A stated multiple of slope height, or a single antecedent-rainfall duration, may be used as a screening prompt to trigger investigation. It shall not be adopted as a design setback or a design trigger without a mechanism-based assessment for the site. Figure 9.2 relates the ground-model features to the design cases.
- 9.3.3** Where cl. 5.3.2 applies, debris-flow and hyperconcentrated-flow runout shall be carried as an explicit design case alongside the slope cases above. The case shall address the deposition depth and the impact action at the facility, the consequence for foundations, walls and openings on the exposed elevation, the effect of deposition on access and evacuation routes, and the performance of any deflection, retention or open check structure relied upon, including its maintenance regime and the consequence of that maintenance lapsing. Parameters are taken from the specialist assessment under cl. 5.3.2.



Figure 9.2 Slope cross-section: ground model features and design cases

9.4 Drainage

Figure 9.3 contrasts a maintained slope-drainage system with the same system after inspection and cleaning have lapsed.

- 9.4.1** Surface and subsurface drainage shall intercept, convey and discharge water without eroding the slope or transferring instability, and shall remain inspectable, cleanable and replaceable.
- 9.4.2** Drainage shall not be credited as a permanent strength system unless blockage, loss of power where pumping is used, outlet failure and lapsed maintenance are included in the design and in the operational controls.

Table 9.3 Slope drainage elements and the failure mode each addresses

Element	Failure mode to address
Crest and interceptor drain	Overtopping, leakage into tension cracks, erosion, debris blockage.
Benches and surface channels	Flow concentration, lining failure, settlement, unsafe discharge.
Subsoil and horizontal drains	Clogging, uncertain influence zone, inaccessible outlets, loss of gradient.
Retaining-wall drainage	Filter migration, outlet blockage, hydrostatic pressure, corrosion.
Outlet and energy dissipation	Toe erosion, scour, neighboring impact, inaccessible inspection.

The same design, two maintenance states



Figure 9.3 Slope drainage in maintained and unmaintained states

9.5 Stabilization and operational control

Table 9.4 Stabilization systems and their design interfaces

System	Design interfaces
Regrading and benching	Land take, spoil, erosion, drainage, access, progressive construction stability.
Retaining wall	Earth, water and seismic actions; global stability; bearing, sliding and overturning; drainage; durability; constructability.
Soil nails and anchors	Ground model, corrosion and service life, bond and proof testing, easements, facing and drainage.
Piles and shear structures	Failure depth, load transfer, deformation compatibility, constructability, monitoring.
Bioengineering	Shallow erosion and root effects, establishment, species, water demand; no credit for deep-seated stability.
Rockfall and debris protection	Source zone, trajectory and volume, energy and capacity, catchment area, maintenance, exceedance.

9.5.1 Slope risk shall be linked to an operational plan identifying observable signs of movement, rainfall and groundwater triggers, the alerting authority, restricted zones, evacuation routes, closure and competent reopening inspection.

10 Deterioration, Heat and Fire

10.1 Whole-life condition

- 10.1.1** The structure and its protective systems shall be designed for the condition expected over the stated service life, not only the condition at handover.
- 10.1.2** Where deterioration can reduce capacity against a hazard, the design shall either demonstrate adequate capacity at the relevant future condition or adopt inspection and intervention triggers before that condition becomes unacceptable. Figure 10.1 illustrates the principal deterioration mechanisms.

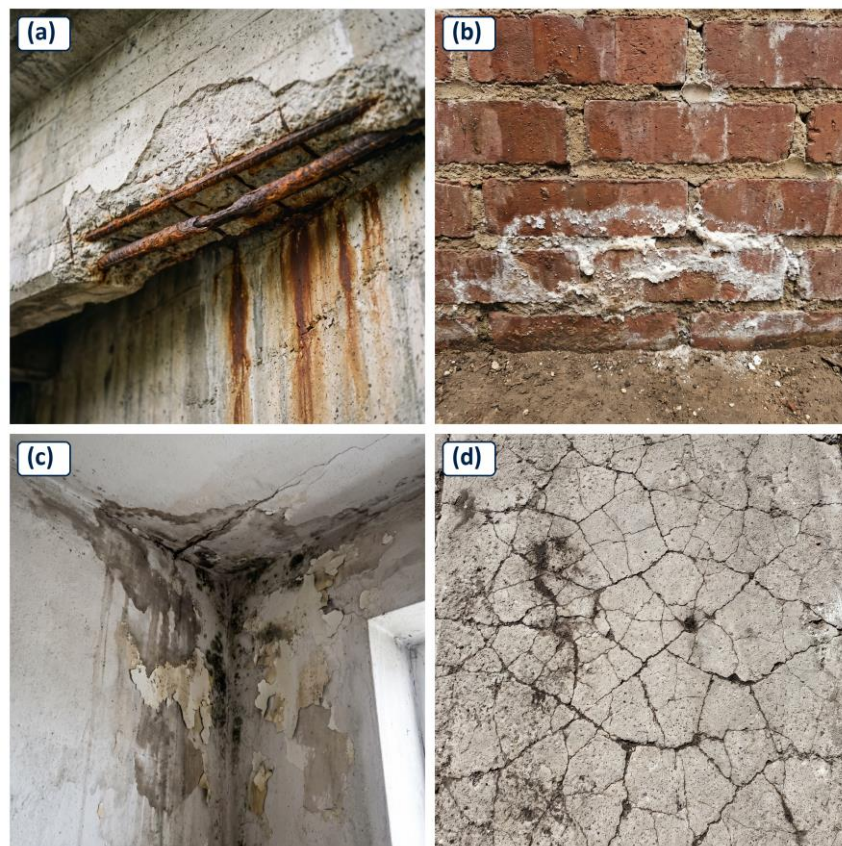


Figure 10.1 Deterioration mechanisms: (a) corrosion and spalling; (b) efflorescence; (c) chronic damp and mould; (d) map cracking

10.2 Durability design

Durability is designed, not added. For concrete, the route is to assign exposure classes for each of the four categories of ACI 318-19 Table 19.3.1.1, freezing and thawing (F), sulfate (S), contact with water (W) and corrosion protection of reinforcement (C), and then to apply the concrete requirements and the specified cover associated with those classes, through BCP-2021 Chapter 19.

- 10.2.1** Cover and concrete quality shall be specified from the assigned exposure classes. A blanket increase applied to the code minimum cover shall not be used in place of exposure classification: an arbitrary increment neither addresses the governing deterioration

mechanism nor guarantees that the concrete quality required for that exposure has been specified.

Table 10.1 Deterioration mechanisms and controls

Mechanism	Design input	Control
Carbonation-induced corrosion	Cover, concrete quality and permeability, cracking, moisture	Water-shedding detail, concrete specification, cover, inspection and repair access.
Chloride-induced corrosion	Coastal or contaminant source, concentration, transport, target service life	Exposure class C2 requirements, cover, barriers, protected reinforcement where justified.
Sulfate and chemical attack	Soil and water testing, concentration, wetting, material compatibility	Exposure class S requirements, cement selection, barriers, drainage, replaceable protection.
Masonry, timber and steel weathering	Moisture, salts, insects, corrosion, decay, interfaces, coatings	Compatible repair, drainage and ventilation, protective systems, inspectable details.
Abrasion, erosion and flood contamination	Flow and debris, cleaning agents, sediment, repeat exposure	Robust and replaceable finishes, isolation, cleaning and recovery plan.

10.3 Water-shedding details

The water-management priority—shed, drain, then resist is shown in Figure 10.2, and Figure 10.3 applies it to the principal envelope interfaces.

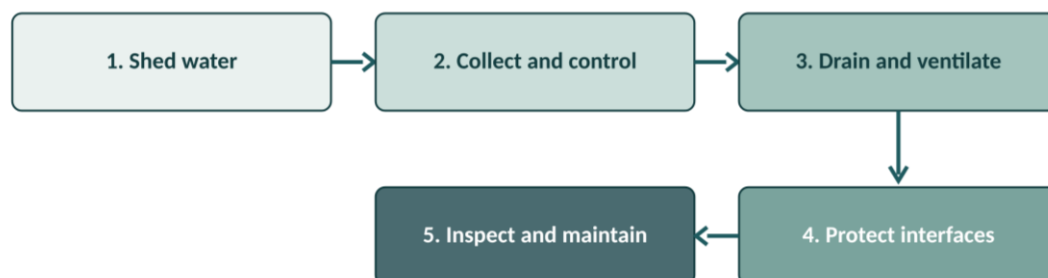


Figure 10.2 Water-management hierarchy

Every interface either throws water clear of the face or gives it a maintained path away

- 1 **Coping with fall and drip**
throws water clear of both wall faces
- 2 **Roof fall, outlet and overflow**
plus a designed overflow for a blocked outlet
- 3 **Upstand and flashing**
turned up and mechanically fixed, not sealant alone
- 4 **Window head throat and drip**
breaks the path down the face
- 5 **Sill with drip and end dams**
water leaves at the ends, not into the reveal
- 6 **Plinth, damp-proof course, falls**
separates rising, splash and flood moisture



Figure 10.3 Water-shedding at the principal envelope interfaces

Table 10.2 Water-shedding detail questions

Interface	Detail question
Roof edge and parapet	Are falls, outlets, overflows, flashings, copings and movement compatible?
Openings and sills	Do drips, throats, end dams and seals discharge water clear of the wall?
Balcony and verandah	Are falls, outlets and upstands provided, and reinforcement exposure controlled?
Wall base and plinth	Are rising, splash and flood moisture separated, and is drainage maintained?
Penetrations and fixings	Are sleeves, sealants, corrosion couples and replacement access resolved?
Below grade	Are waterproofing, protection, drainage and hydrostatic cases coordinated?

10.4 Extreme heat

Figure 10.4 shows the passive measures that keep a facility usable while mechanical cooling is degraded or unavailable.

10.4.1 Heat-resilience design shall address occupant health, learning and clinical function, equipment and medicine limits, energy demand, power outage, and safe operation while mechanical cooling is degraded or unavailable.

Table 10.3 Passive heat-resilience design layers and questions

Layer	Design questions
Site and outdoor space	Shade, surface temperature, trees and canopies, waiting and play areas, water, access, night-time heat release.
Form and envelope	Orientation, shading, glazing, insulation, roof construction, thermal mass, air leakage, moisture interaction.
Ventilation and indoor air	Natural and mixed-mode paths, outdoor air quality, security, noise, infection control, night purge.
Efficient systems	Zoning, controls, maintenance, peak demand, equipment limits.
Power failure	Passive survivability period, backup supply, priority loads, safe shutdown.

Layer	Design questions
Operation	Heat alerts, occupancy and work schedules, hydration, vulnerable users, monitoring.

The facility must remain safely usable while mechanical cooling is degraded or unavailable

- 1 **Reflective, insulated roof**
the largest gain on a low block
- 2 **Shading to openings**
overhang or screen, sized for orientation
- 3 **Cross ventilation, night purge**
low inlet, high-level outlet
- 4 **Thermal mass that can discharge**
of little use without night ventilation
- 5 **Trees and shaded outdoor space**
surface temperature, waiting areas
- 6 **Backup supply, priority loads**
passive survivability period defined



Illustrative section. Orientation, climate data and clinical or learning requirements govern the project design.

Figure 10.4 Passive heat-resilience measures in section

10.4.2 Indoor operative-temperature limits and passive-survivability durations shall be stated for classrooms and teaching spaces, for wards, treatment and delivery rooms, and for medicine stores and the cold chain. Where the owner or the AHJ has not set values, the defaults in Table 10.4 shall be adopted and recorded as adopted. They are adoptable defaults for design, not national thresholds, and they do not displace a value set by the AHJ, by the owner, or by a product requirement for stored medicines or vaccines.

Table 10.4 Indicative indoor criteria and passive survivability, adoptable defaults

Space	Indicative indoor criterion	Passive survivability	Basis and source
Classroom and teaching space	Operative temperature not exceeding 30 °C for more than 5 per cent of occupied hours, with air movement available; 32 °C treated as the absolute upper limit beyond which occupancy is reviewed.	Space remains usable for 72 hours without mains power, with openable ventilation and shading only.	Adaptive comfort basis of ASHRAE 55 and BS EN 16798-1, applied with the envelope and ventilation measures of clause 10.4.1 and the build-ups at clause 11.3; BCP Energy Provisions 2011.
Ward, treatment and delivery room	Operative temperature within 18 °C to 27 °C during occupied hours; the clinical requirement governs where it is narrower.	Space remains usable for 72 hours without mains power for general ward function; critical clinical areas are served by standby power and are not designed on passive survivability alone.	WHO guidance on climate-resilient and environmentally sustainable health care facilities; clinical and infection-control requirement under clause 12.3.
Medicine store	Controlled room temperature not exceeding 25 °C, with	Storage condition maintained for a	WHO Model Guidance for the storage and transport

Space	Indicative indoor criterion	Passive survivability	Basis and source
	humidity controlled to the product requirement.	minimum of 24 hours without mains power, by thermal mass, insulation and shading before mechanical means.	of time- and temperature-sensitive pharmaceutical products.
Cold chain and vaccine storage	Storage compartment maintained at 2 °C to 8 °C.	Holdover time stated by the equipment specification and verified against the local outage duration; the design shall not assume continuous power.	WHO Performance, Quality and Safety (PQS) requirements for cold-chain equipment.

10.4.3 The criteria at Table 10.4 shall be met by the passive layers at clause 10.4.1 and by the build-ups selected under clause 11.3 before mechanical cooling is relied upon. Mechanical cooling shall not be used to correct an envelope, orientation or shading decision that could have been made at design stage.

10.4.4 Compliance shall be demonstrated by the route proportionate to the tier at clause 2.5: at Tier 1 by prescriptive envelope, shading and ventilation measures recorded against Table 10.4; at Tier 2 by a simplified calculation of the governing spaces; and at Tier 3 by thermal simulation of the critical spaces under design-summer conditions, including the degraded state with mechanical cooling unavailable.

10.5 Fire and life safety

10.5.1 Fire and life-safety design shall comply with the Building Code of Pakistan, Fire Safety Provisions 2016 and the requirements of the local fire authority. These Guidelines add resilience interfaces; they do not replace fire engineering, approval, inspection or emergency planning. Representative event chains are shown in Figure 10.5.

Table 10.5 Fire and life-safety resilience interfaces

System	Resilience interface
Ignition control	Electrical, cooking, laboratory, oxygen and medical gas, fuel, battery and photovoltaic installations, waste.
Detection, alarm and communication	Coverage, power supply, audibility and visibility, accessibility, degraded-network operation.
Compartmentation	Fire and smoke barriers, penetrations, doors, dampers, post-hazard damage.
Egress	Capacity, travel distance, locking, lighting, signage, accessibility, external route hazards.
Suppression and water	Source, storage, pumps, power, seismic restraint, flood protection, maintenance.
Emergency response	Access, hydrants, isolation, assembly, drills, reoccupation.

10.6 Cascading hazards

Table 10.6 Cascading hazard sequences by initiating event

Initiating event	Structural state	Ignition	Utilities	Access and response
Earthquake	Damage and residual drift	Gas and electrical ignition	Rupture and outage	Debris, blocked egress
Flood	Scour and contamination	Electrical and battery risk	Submergence and backflow	Cut-off
Extreme heat	Thermal movement	Electrical and wildland fire	Peak demand and outage	Heat stress
Wind	Envelope and roof damage	Line damage and debris	Outage	Blocked routes
Slope movement	Foundation and impact damage	Line rupture	Water and power rupture	Road loss

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Earthquake	Damage and residual drift	Gas/electrical ignition	Rupture and outage	Debris, blocked egress
Flood	Scour and contamination	Electrical/battery risk	Submergence and backflow	Cut-off
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Wind	Envelope/roof damage	Line damage and debris	Outage	Blocked routes
Slope movement	Foundation/impact damage	Line rupture	Water/power rupture	Road loss

Figure 10.5 Cascading hazard sequences

10.6.1 The emergency plan and the design shall identify safe isolation, inspection and reinstatement sequences. Automatic restart after an event shall not occur where it could cause fire, contamination or equipment damage.

11 Climate-Appropriate Materials and Build-Ups

Material selection decides how a facility performs against every hazard acting on it, how it behaves in heat, whether it can be built correctly at the district in which it stands, and whether the owner can maintain it. This chapter sets how that selection is made and recorded. It does not specify a material for a project; it fixes the tests a material must pass and the evidence each requires.

11.1 Basis of selection

11.1.1 Material selection shall follow from the hazards established at Chapter 3 and Chapter 5, the exposure classification at clause 10.2, the facility classification and performance objectives at Chapter 6, the intervention class at Chapter 13, and the heat criteria at clause 10.4. It shall be recorded in the design basis report at clause 4.3. A material shall not be selected on unit rate alone, nor by repetition of a previous project.

11.1.2 A material is climate-appropriate for a project when it satisfies all five of the following tests: it performs acceptably against every hazard acting on the facility; it remains durable in the exposure class of the site for the design service life; it contributes to the indoor conditions required by clause 10.4; it can be obtained, produced and worked at the district in which the facility is built; and it can be maintained by the party that will own and operate the facility.

11.1.3 Where the five tests conflict, the conflict shall be resolved explicitly and recorded with its reasons. It shall not be settled by selecting the material that satisfies one test best while leaving the others unexamined.

11.1.4 Material selection shall be tested against the degraded state as well as the design event. A material whose performance depends on maintenance that the owner cannot deliver shall be treated as failing the fifth test at clause 11.1.2, whatever its performance when new.

11.2 Performance against the design hazards

The table below sets the hazard behaviour that governs the selection of each material family in school and basic health-unit construction in Pakistan. It records what has to be checked, not a permission to use.

Table 11.1 Material families and their governing hazard behaviour

Material family	Seismic	Flood and moisture	Wind	Deterioration and fire
Confined masonry, fired clay brick or concrete block	Good where tie-columns and tie-beams are continuous and the wall is confined on all four sides; performance is lost entirely where confinement is	Fired brick tolerates wetting and drying; mortar and plinth protection govern. Requires a damp-proof course and a plinth above the design flood level.	Adequate mass; the roof-to-wall connection, not the wall, governs.	Sulphate and salt attack in aggressive ground; efflorescence; non-combustible.

Material family	Seismic	Flood and moisture	Wind	Deterioration and fire
	interrupted for an opening.			
Reinforced concrete frame with masonry infill	Infill changes the frame's stiffness and can produce short-column and soft-storey failure; the infill shall be designed as participating or isolated, never left unexamined.	Durable if cover and concrete quality meet the exposure class; reinforcement corrosion is the governing long-term risk after inundation.	Good, with envelope and cladding fixings governing.	Chloride and carbonation-driven corrosion; cover and concrete quality govern; non-combustible.
Reinforced concrete shear wall	Strong and stiff; foundation demand and detailing at boundary elements govern.	Good resistance to inundation and to flow-borne debris; construction joints govern.	Excellent.	As for concrete frame; low maintenance demand.
Unreinforced masonry, existing stock	Poor. Out-of-plane failure of walls is the dominant life-safety mechanism; retrofit under Chapter 13 is required before an existing URM facility is certified.	Mortar erosion and foundation softening on inundation.	Poor at gable walls and parapets, which shall be restrained or removed.	Vulnerable to moisture cycling; non-combustible.
Steel frame with profiled sheet envelope	Light and ductile if connections are designed and executed; connection quality governs.	Corrosion at the splash and inundation zone; base plates and anchor bolts govern.	Uplift at the roof is the governing action; fastener type, placement and edge and corner zones govern.	Corrosion protection specification and its maintenance govern; insulation and lining determine fire behaviour.
Timber and bamboo	Light and ductile; connection detailing and species-specific capacity govern.	Requires elevation above the design flood level and ventilated construction; ground contact shall be avoided.	Requires a continuous, mechanically fastened load path; nails alone are not sufficient.	Decay, termite and fungal attack; treatment, detailing and inspection govern; combustible, requiring separation and detection.
Stabilized earth block and adobe, existing stock	Poor unless reinforced and confined; commonly requires replacement or substantial retrofit for Risk Category III and IV.	Very sensitive to inundation and rising damp; not suitable below the design flood level.	Adequate mass; roof connection and eaves protection govern.	Erosion by driving rain; requires a maintained protective finish; non-combustible.

Material family	Seismic	Flood and moisture	Wind	Deterioration and fire
Light-gauge steel or prefabricated panel systems	Light; performance depends entirely on the connection and diaphragm design.	Panel core absorption and joint sealing govern; flood-damaged panels are commonly not repairable.	Uplift and racking; anchorage to foundation governs.	Thermal performance is set by the core; fire behaviour of the core shall be evidenced before use in an occupied school or health facility.

11.2.1 A material family shall not be selected where the table records a governing behaviour that the project cannot control. Where a family is selected despite an adverse behaviour, the control that makes it acceptable shall be named in the specification and carried to an inspection hold point under clause 15.6.

11.3 Thermal and moisture behaviour of common build-ups

The build-ups below are those in common use for schools and basic health units in Pakistan. The purpose of the table is to make the thermal consequence of a routine construction choice visible at the point the choice is made, and to connect it to the heat criteria at clause 10.4.

Table 11.2 Thermal and moisture behaviour of common school and BHU build-ups

Build-up	Thermal behaviour	Moisture behaviour	Application under clause 10.4
230 mm solid fired-brick wall, plastered both faces	High thermal mass, slow response; moderates daily swing but stores heat in a prolonged heatwave and re-radiates at night.	Tolerant of wetting and drying; requires a damp-proof course and adequate plinth.	Acceptable in composite and hot-dry districts where night ventilation is available; insufficient alone where night temperatures remain high.
115 mm brick wall, plastered	Low mass and low resistance; follows outdoor temperature closely.	As above, with reduced tolerance to driving rain.	Not acceptable as the sole envelope for an occupied classroom or ward in a hot district without shading and added insulation.
Hollow concrete block wall, plastered	Lower mass than solid brick; performance depends on block density and whether cores are filled.	Requires a maintained external finish; shrinkage cracking is a driving-rain path.	Acceptable with external shading; core filling or insulation required where the west and south-west elevation is exposed.
RC roof slab, no insulation or terracing	Very poor. The uninsulated roof is the dominant heat gain in a single-storey school or BHU and the most common cause of failure against clause 10.4.	Requires a maintained waterproofing layer; ponding at parapet drains is the common defect.	Not acceptable for an occupied space in any hot district. Insulation, terracing or a ventilated over-roof is required.

Build-up	Thermal behaviour	Moisture behaviour	Application under clause 10.4
RC slab with mud-phuska and brick-tile terracing	Substantially improved over the bare slab; adds mass and a low-conductivity layer using locally available materials.	Requires slope, drainage and a maintained tile surface; failure is progressive and inspectable.	Acceptable and locally producible; a low-regret measure under clause 3.8.
Profiled metal sheet on steel purlins, uninsulated	Very poor. Rapid heat gain, high surface temperature and radiant discomfort immediately below.	Condensation on the underside in cool nights; corrosion at fasteners and laps.	Not acceptable over an occupied classroom or ward without insulation and a ventilated cavity or a suspended ceiling with ventilation above it.
Insulated sheet or sandwich panel roof	Good, provided the insulation is continuous and thermal bridging at purlins and laps is controlled.	Joint sealing governs; the core shall not absorb water.	Acceptable; the fire behaviour of the core shall be evidenced before use over an occupied space.
Stabilized earth block wall, rendered	High mass and good daily-swing performance; locally producible with low embodied carbon.	Requires a maintained render, a generous roof overhang and a plinth well above ground; not suitable where inundation is possible.	Acceptable in hot-dry districts for Tier 1 facilities where the structural provisions of clause 11.2 are satisfied.

11.3.1 The roof shall be examined before the wall in any facility in a hot district. In a single-storey school or basic health unit the roof is the dominant heat gain, and a wall improvement applied to an uninsulated roof will not deliver the criteria at clause 10.4.

11.3.2 Envelope decisions shall be checked against the Building Code of Pakistan, Energy Provisions 2011, and the applicable provision recorded in the design basis report. Where these Guidelines and the Energy Provisions both apply, the Energy Provisions govern as adopted code under clause 2.1.

11.3.3 A thermal improvement shall not be adopted where it conflicts with a hazard or clinical requirement without the conflict being resolved under clause 12.4. Sealing a building for thermal performance against the ventilation and infection-control requirement of a health facility is the common instance.

11.4 Availability, producibility and workmanship

11.4.1 Before a material is specified, the design shall record its availability at district level: whether it is produced within the district or region, the lead time and transport route, whether that route is itself exposed to the hazards identified at Chapter 5, and whether a comparable substitute exists if supply fails. A material available only through a single supply route that floods is a resilience risk in the construction phase and shall be recorded as such.

11.4.2 The design shall record the workmanship on which each material depends and the control that secures it. Where the required workmanship is not reliably available in the district, the material shall not be specified unless the control is named in the specification, carried to a hold point under clause 15.6, and reflected in the construction programme and price.

Table 11.3 Workmanship dependence and the control required

Material or element	What the performance depends on	Control required before it is accepted
Confined masonry tie-columns and tie-beams	Continuity of ties around every opening, sequence of casting after the wall, and lap and anchorage at junctions.	Sequence stated on the drawing; hold point at reinforcement fixing before casting; photographic record of each junction.
Concrete cover and quality in aggressive ground	Cover to reinforcement, mix design, compaction and curing.	Cover meter check; cube results against the exposure class of clause 10.2; recorded curing regime.
Roof sheet fastening for wind uplift	Fastener type, placement relative to crown or valley, spacing in edge and corner zones, and washer condition.	Approved system detail; hold point at first bay; pull-out test where the substrate is not to the system specification.
Corrosion protection to steelwork	Surface preparation, coating thickness and coating of connections after erection.	Dry-film thickness readings; inspection of connections and cut edges before enclosure.
Timber and bamboo connections	Species, moisture content at fixing, preservative treatment and mechanical fastener type.	Certificate of treatment; moisture content recorded at fixing; sample connection approved before repetition.
Waterproofing and roof terracing	Slope, laps, upstands at parapets, and outlet detailing.	Flood test of the roof before the finish is laid; hold point at outlets and upstands.

11.5 Low-carbon and low-regret options

11.5.1 Retaining and strengthening an existing structure under Chapter 13 is often offers a lower-carbon option, subject to whole-life assessment and may improve local repairability to a project, and shall be evaluated before replacement is adopted. Where replacement is selected, the reasons shall be recorded under clause 13.2.

11.5.2 Locally produced materials shall be preferred where they satisfy clause 11.1.2, because they shorten the supply route, reduce embodied transport, and are repairable by the party that will maintain the facility.

11.5.3 Blended cements and supplementary cementitious materials may be adopted where the exposure class at clause 10.2, the required early strength and the available curing regime permit. The adopted binder shall be stated in the specification and shall not be varied on site without review.

11.5.4 Over-specification is not conservatism. Specifying a strength, a section or a protective system beyond what the design requires adds cost and embodied carbon without adding resilience, and shall be avoided.

11.6 Selection matrix and record

The matrix below is the record of the selection decision. It is completed for each principal element and retained in the design basis report.

Table 11.4 Material selection matrix

Element	Test	Question to answer	Evidence retained
Each principal element: foundation, wall, frame, roof, floor, envelope and finishes	Hazard performance	Does the material behave acceptably against every hazard acting on this facility, and is the governing behaviour at Table 11.1 controlled?	Hazard schedule reference and the named control.
	Durability	Is the material durable in the exposure class of the site for the design service life, with the maintenance the owner can deliver?	Exposure class under clause 10.2 and the service-life assumption.
	Thermal and moisture behaviour	Does the build-up deliver the criteria at clause 10.4 and Table 10.4 without relying on mechanical cooling?	Build-up reference at Table 11.2 and the compliance route at clause 10.4.4.
	Availability and workmanship	Is the material obtainable at the district, and is the workmanship it depends on available and controlled?	Availability record under clause 11.4.1 and the hold point under clause 11.4.2.
	Maintainability and carbon	Can the owner maintain it, and has a lower-carbon option satisfying the other four tests been considered?	Operation and maintenance assumption and the record under clause 11.5.

11.6.1 The completed matrix shall be recorded in the design basis report at clause 4.3 and registered against its clause in the clause-to-evidence register at clause 15.2.

11.6.2 A material substitution proposed during construction shall be tested against the same five tests and shall not be accepted on price or availability alone. A substitution that changes the hazard behaviour at Table 11.1, the thermal behaviour at Table 11.2 or the workmanship control at clause 11.4.2 is a design change and shall be reviewed and recorded under Annex C before it is built.

11.6.3 The evidence required by this chapter is proportionate to the tier at clause 2.5. At Tier 1 the matrix may be completed from the tables in this chapter and a district availability check. At Tier 2 and Tier 3 the thermal route at clause 10.4.4 and the durability route at clause 10.2 shall be evidenced by calculation for the governing elements.

12 Facility-Specific Resilience

12.0.1 The project shall define the services, users, occupancy pattern, vulnerable groups, critical spaces, equipment, dependencies and acceptable downtime before resilience measures are selected.

12.0.2 A building-level objective shall be decomposed into system-level objectives. A structurally usable facility may still be unable to teach, treat patients, shelter people or operate safely if water, sanitation, power, indoor conditions or access fail.

12.1 Schools

Figure 12.1 shows the dependencies on which a school's learning function rests.

Table 12.1 School functional resilience questions and outputs

Function	Resilience question	Output
Daily learning	Can classrooms, sanitation, access, ventilation, daylight, power and temperature support safe learning?	Room and system criteria with operational limits.
Child safety and safeguarding	Do routes, visibility, boundaries, temporary works and emergency arrangements protect children?	Safeguarding review is integrated with the design and works plan.
Inclusive access	Can children and staff with disabilities use safe routes, sanitation, alerts and evacuation?	Accessibility and assistance-evacuation record.
Gender-responsive facilities	Are sanitation, privacy, lighting, access and management appropriate and secure?	User and owner requirements with verified layouts.
Continuity during works	Can teaching continue safely, or is phased or temporary accommodation required?	Decant and phasing plan, separation, noise and dust control, emergency controls.
Post-event recovery	What inspection, cleaning, temporary learning and repair routes are available?	School continuity and reopening protocol.

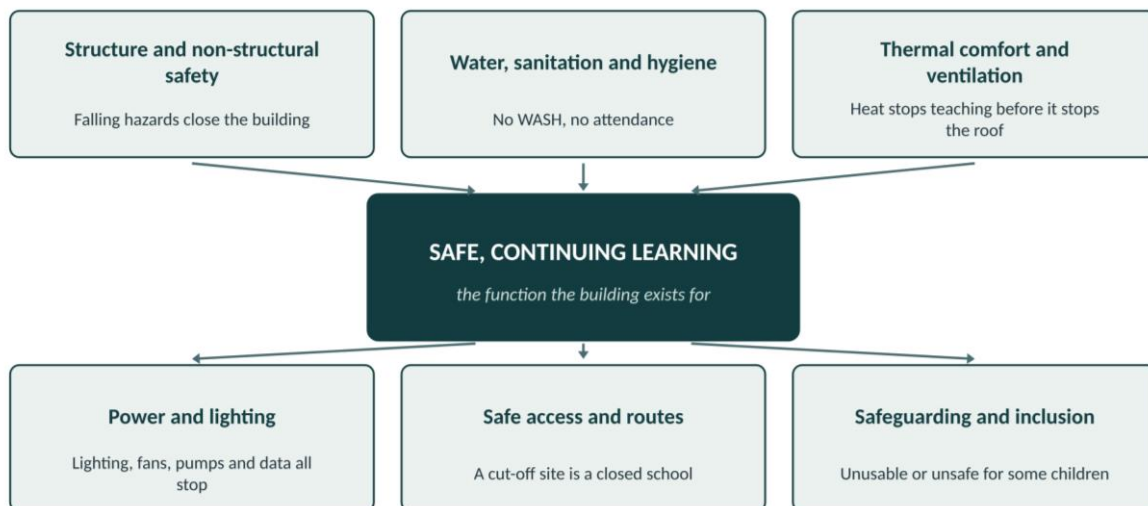


Figure 12.1 School functional-resilience dependencies

12.2 Schools used as emergency shelters

12.2.1 Shelter use shall rest on a formal decision by the owner or the responsible authority. An informal expectation that a school will become a shelter shall be resolved at briefing stage and not left as an uncoded assumption. A designated shelter is Risk Category IV under BCP-2021 Table 1604.5.

Table 12.2 Requirements for a school used as an emergency shelter

Requirement	Design and operations record
Occupancy and duration	People, duration, season, sleeping and space plan, management arrangements.
Structural and non-structural objective	Required post-event condition and inspection route.
Access and site safety	Emergency vehicle, pedestrian, accessible and supply routes.
Water, sanitation and hygiene	Quantity, storage, treatment, toilets, waste, privacy.
Power, lighting and communications	Priority loads, backup duration, fuel and battery, controls.
Health, protection and inclusion	First aid, vulnerable users, safeguarding, gender-responsive arrangements.
Return to education	Separation, cleaning, repair and hand-back criteria.

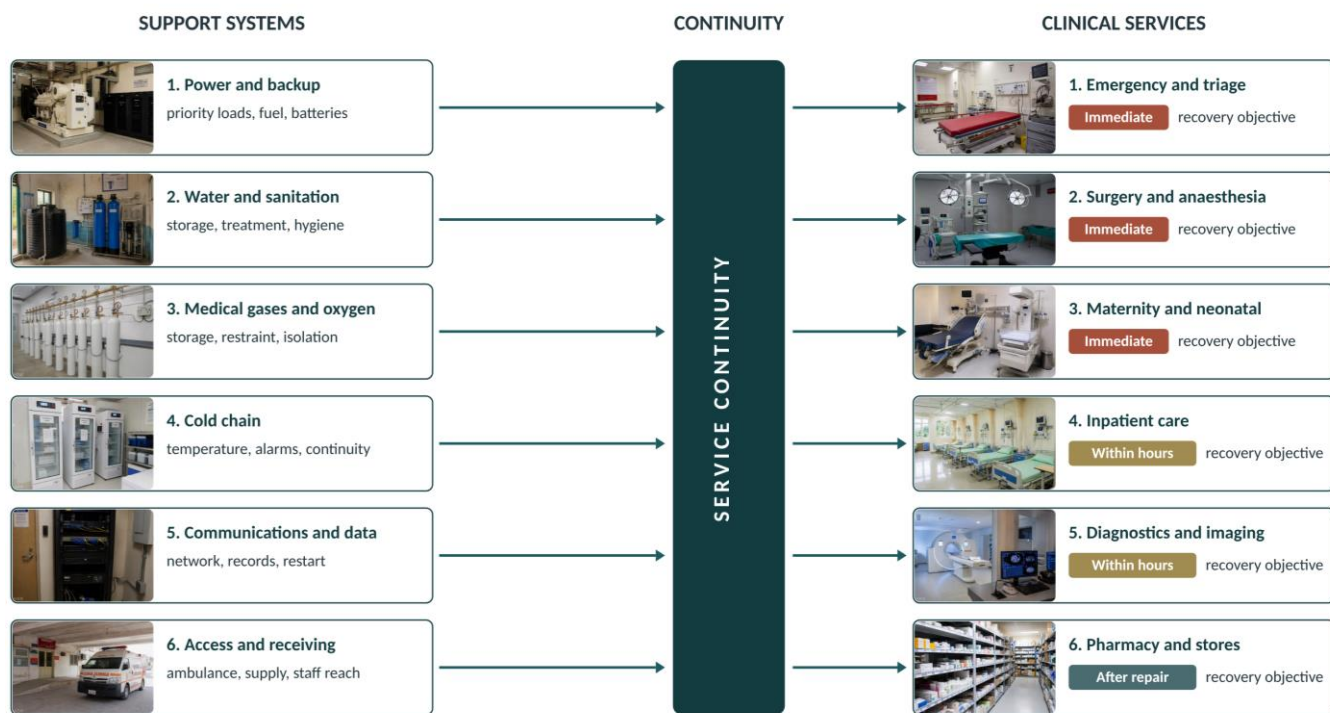
12.3 Health facilities

Figure 12.2 shows the support systems on which clinical services depend.

Table 12.3 Health-facility resilience questions and outputs

System	Resilience question	Output
Clinical service priorities	Which services must continue immediately, within hours, or after repair?	Department and service recovery objectives.

System	Resilience question	Output
Patients and evacuation	Which patients cannot self-evacuate, and what refuge or transfer is needed?	Evacuation, refuge and transfer strategy with staffing assumptions.
Medical gases and oxygen	Are storage, restraint, distribution, isolation, ventilation and fire interfaces controlled?	System design, zone isolation, emergency procedure.
Cold chain and medicines	What temperature, power and monitoring continuity is required?	Priority load, backup duration, alarms, contingency.
Water, sanitation and infection control	Can safe water, hand hygiene, waste handling and isolation function during disruption?	Storage and treatment, priority distribution, contingency.
Diagnostics and records	What anchorage, environmental control, data protection and restart sequence is required?	Equipment and service schedule with recovery plan.
Ambulance and supply access	Can routes and receiving areas operate during the design event?	Access levels, alternative routes, external coordination.



Illustrative photographs for context only; they are not project evidence (Section 1.4).

Figure 12.2 Health-facility service dependencies and recovery objectives

- 12.3.1** A passive ventilation, shared-space or water-reuse measure shall not be adopted for a health facility without checking the clinical and infection-control consequence.
- 12.3.2** The resilience of a health facility shall be assessed and recorded using the PAHO/WHO Hospital Safety Index, at the level appropriate to the facility, together with the WHO guidance on climate-resilient and environmentally sustainable health care facilities. For a basic health unit, the safe-hospital checklist is applied proportionately under clause 2.5. The resulting index or checklist score, its date and its assessor shall be recorded in the design basis report at clause

4.3, the modules scoring lowest shall be addressed in the design, and the score shall be restated after the works.

12.3.3 Where the Hospital Safety Index identifies a structural, non-structural or functional module as inadequate and the project does not address it, the omission shall be carried as a residual risk under clause 15.5 with a named acceptance. It shall not be left unrecorded.

12.4 Environmental performance interfaces

Environmental performance measures and hazard resilience are designed together. Where the two conflict, the conflict is resolved explicitly and recorded.

Table 12.4 Conflicts to resolve between environmental and resilience measures

Potential conflict	Resolution question
Airtightness against natural ventilation and infection control	What operating modes and controls deliver safe air quality, heat resilience and energy performance together?
Rooftop solar arrays and equipment against wind and seismic demand	Are added mass, uplift, anchorage, fire, waterproofing and maintenance access coordinated?
Rainwater storage against structural, flood and health constraints	Are tank loads, anchorage, water quality, overflow and contamination controlled?
External shading and trees against wind, fire and security	Are supports, fall zones, fuel load, visibility and maintenance acceptable?
Permeable landscape against foundations and slope stability	Are infiltration, groundwater, settlement and slope effects assessed?
Flood-resistant finishes against indoor air quality goals	Are materials cleanable, dryable, low-emitting and compatible with the exposure?

12.5 Gender equality and social inclusion

A facility that is structurally sound but that a disabled child cannot enter, that a girl will not use because the sanitation is neither private nor safe, or that cannot be evacuated by a person who cannot use stairs, has not met its public function. The requirements below are design requirements under clause 1.4 and are verified at certification.

12.5.1 The design shall comply with the General Accessibility Guidelines — Guidelines for Accessibility and Inclusive Design in Public Buildings in Pakistan, issued August 2025 under GIZ project number 20.2265.5-005.00, which apply to educational and health-care facilities and give the governing dimensions for movement areas, stairs, ramps, doors, signage, tactile warning surface indicators, sanitary facilities and escape routes. Section 4.2 (School) and section 4.4 (Healthcare) of that document apply to the facility types covered by these Guidelines. Where the Authority Having Jurisdiction or the owner adopts a different accessibility standard, it shall be named in the design basis report at cl. 4.3 and shall not provide a lower level of accessibility than the adopted guidelines.

Table 12.5 Gender equality and social inclusion design requirements and their evidence

Domain	Design requirement	Evidence at certification
Access and circulation	A continuous accessible route from the site entrance to every function of the facility, including ramps at the adopted gradient, thresholds, door widths and clear manoeuvring space. Where a first floor carries a teaching or clinical function, an accessible equivalent shall be provided at ground level or by vertical access.	Accessible route shown on the drawings and dimensioned; gradient and width checked against the adopted standard.
Sanitation and WASH	Separate, lockable, lit sanitation for girls and for boys, and for women and men, with menstrual hygiene management provision, a water supply inside the cubicle, waste disposal, and at least one accessible unit. Sanitation shall not be located where its approach is unobserved or unlit.	Layout, fixture schedule and lighting; approach route reviewed for visibility and safety.
Evacuation and refuge	A disability-inclusive evacuation strategy stating how a person who cannot use stairs, a patient who cannot self-evacuate, and a young child are moved or protected, with a refuge where evacuation is not immediately possible and the staffing assumption that the strategy relies on.	Evacuation strategy document with named refuge locations and the staffing assumption recorded.
Learning and clinical spaces	Sightlines, acoustics, lighting and furniture layout that allow a child with a sensory or mobility impairment to participate, and clinical spaces that allow privacy for examination and for delivery.	Room data sheets and layout drawings.
Safety and safeguarding	Boundaries, lighting, visibility and supervision arrangements designed so that children are not isolated from view, including during construction and temporary works, consistent with clause 4.5.	Site safety and safeguarding plan for the works, and the completed facility layout.
Participation	Female staff, and where appropriate female students or patients and persons with disabilities, consulted on sanitation, safety and access before the layout is fixed.	Record of consultation, dated, with the decisions it changed.

12.5.2 Compliance with this clause shall be verified at the final issue checklist at clause 15.7 and recorded in the Design Compliance Certificate at Table 15.3. A design shall not be certified compliant with these Guidelines without that evidence.

12.5.3 Where a requirement of this clause cannot be met, the shortfall shall be recorded as a residual risk under clause 15.5, naming the affected users, the reason, the interim arrangement and the named acceptance. It shall not be omitted from the record.

12.6 Facility resilience schedule

The design records, for each critical service, how it behaves in normal operation, during the design event, in a degraded state, and how it is recovered.

Table 12.6 Facility resilience schedule

Service or system	Normal	Design event	Degraded	Recovery target and owner
Occupancy and critical services				
Power and lighting				
Water, sanitation and drainage				
Ventilation and thermal conditions				
Medical and learning equipment				
Access, evacuation and communications				
ILLUSTRATIVE — NOT A PROJECT RECORD: water supply to a 4-classroom primary school, district example	Piped supply, 2 taps per block, 500 L overhead storage.	Supply interrupted; storage assumed full at onset.	Handpump on site remains usable; storage sized for 3 days at 5 L per child per day.	Supply restored within 7 days; storage refilled by tanker if not. Owner: Assistant Education Officer, district.

13 Intervention Selection and Strengthening Measures

13.1 Selecting the intervention

13.1.1 The intervention shall address the diagnosed mechanism and the service objective. A familiar technique shall not be selected first and justified afterwards.

Table 13.1 Intervention classes, when each is used and the evidence required

Class	Use when	Required evidence
Repair	The intended performance remains adequate, but damage or deterioration must be made good and its cause controlled.	Diagnosis, capacity consequence, repair objective, compatibility, quality control, service-life plan.
Retrofit	The assessed system does not meet the objective, and a feasible strengthening, load-path or demand-reduction measure exists.	Assessed deficiency, option calculations, foundation and interface effects, design and independent review.
Reconstruct	The existing configuration or condition cannot feasibly meet the objective, or whole-life analysis supports replacement.	Site check, replacement design basis, lifecycle and continuity analysis, owner and AHJ decision.
Relocate	Site or network exposure remains unacceptable, or another site offers a materially better whole-life outcome.	Site comparison under Chapter 5, service network analysis, institutional decision.

Monitoring as a deferred-decision status. Monitoring is not an intervention class. It may be adopted temporarily where evidence supports continued controlled use while a defined trigger, further investigation or a later project stage is awaited. The monitoring plan shall define the baseline, method, limits, frequency, trigger value, action owner and consequence of missed action. When the trigger is reached, the facility shall be reclassified as Repair, Retrofit, Reconstruct or Relocate. Where "Monitor" is used in project forms it shall be labelled a decision status, not an intervention class.

13.1.2 Life safety, legal compliance and a material site exclusion are gates. They shall not be traded against a favorable cost score.

13.2 Whole-life cost comparison

Where strengthening is technically viable, the choice between strengthening and replacement is expressed as a ratio of whole-life intervention cost to equivalent replacement cost.

$$R = C_{\text{intervention}} / C_{\text{replacement}} \quad (13.1)$$

13.2.1 The comparison shall state what each term includes: measured works with the price date; design, investigation, approval and supervision; decant and service continuity; risk allowance; whole-life operation and maintenance; and salvage. A ratio quoted without that basis is not comparable between facilities.

- 13.2.2** Any threshold applied to the ratio is a program policy adopted and recorded by the owner, the financing institution or the AHJ, together with the authority permitted to grant an exception. It is not a code requirement and not an engineering constant.
- 13.2.3** As the ratio approaches unity, replacement becomes increasingly competitive and shall be evaluated alongside residual service life, code compliance, disruption and decant requirements, continuity of service, future maintenance, environmental or heritage constraints, and the owner's program policy. Where no decision threshold has been adopted, the design shall report the ratio with its basis and refer the intervention decision to the owner.
- 13.2.4** The comparison shall be made on a discounted basis. The design shall state the discount rate, the appraisal period and the price base, each recorded as an owner or financing-institution decision under clause 13.2.2, and shall express the terms as present values at a common date. An undiscounted sum of costs arising at different times is not a valid comparison, because it systematically favors the option whose costs fall furthest into the future. Where an undiscounted ratio is reported for illustration, it shall be labelled as undiscounted and shall be accompanied by the discounted comparison.

13.3 Strengthening measures

The measures below are technique families. Each requires project-specific design, calculation, detailing, specification, sequencing and review before it is built.

Table 13.2 Strengthening technique families

Ref	Technique	Applicable systems	Deficiency addressed
R-01	Added reinforced-concrete shear walls	Concrete frames; assessed masonry interfaces	Global strength and stiffness; correction of irregularity
R-02	Added steel bracing	Concrete and steel frames	Global stiffness and strength; correction of irregularity
R-03	Diaphragm ties and wall anchorage	Unreinforced, confined and stone masonry	Load-path continuity and out-of-plane restraint
R-04	Reinforced-concrete or compatible jacketing	Concrete members; assessed masonry	Member strength, stiffness or confinement
R-05	Fibre-reinforced polymer strengthening	Verified concrete and masonry substrate	Confinement, shear or local strengthening
R-06	Added confining elements to masonry	Assessed unreinforced masonry	System integrity and out-of-plane performance
R-07	Underpinning and scour protection	All systems, mechanism-specific	Foundation support, settlement or scour
R-08	Mass reduction and roof replacement	Masonry and light-roof buildings	Reduced demand and improved roof system
R-09	Storey removal and configuration reduction	Assessed multi-storey buildings	Reduced demand or removal of irregularity

Ref	Technique	Applicable systems	Deficiency addressed
R-10	Crack injection and continuity repair	Concrete and masonry	Restored continuity; not automatic strengthening
R-11	Patch repair with corrosion control	Concrete elements	Removal of unsound material, control of cause, restored section and protection
R-12	Electrochemical durability treatment	Concrete with verified mechanism	Management of chloride and carbonation corrosion



Figure 13.1 Conceptual overview of the canonical R-01 to R-12 retrofit-technique families

13.4 Matching technique to deficiencies

Table 13.3 Matching technique families to diagnosed deficiencies

Deficiency	Candidate techniques	Checks before selection
Global lateral strength and stiffness	R-01, R-02, R-04	Demand and capacity, torsion and irregularity, diaphragm and collector, foundation, architectural and services impact.
Masonry load path and out-of-plane behaviour	R-03, R-06	Wall and material condition, diaphragm, anchors, parapets and gables, foundation, compatible finishes.
Member or local deficiency	R-04, R-05	Mechanism, substrate and material, force redistribution, ductility, fire and durability, quality control.
Foundation, scour and settlement	R-07	Cause, hydraulics and geotechnics, load transfer, sequence, adjacent movement.

Deficiency	Candidate techniques	Checks before selection
Excess mass and poor roof system	R-08	Demand reduction; new roof wind and seismic load path; thermal, fire and water performance.
Configuration or storey irregularity	R-01, R-02, R-09	Whole-building analysis, service and egress, vertical systems, foundation effects.
Cracking and deterioration	R-10, R-11, R-12	Cause, structural effect, contaminants, moisture, compatibility, service-life strategy.

Figure 13.2 combines the intervention-class decision with technique matching.

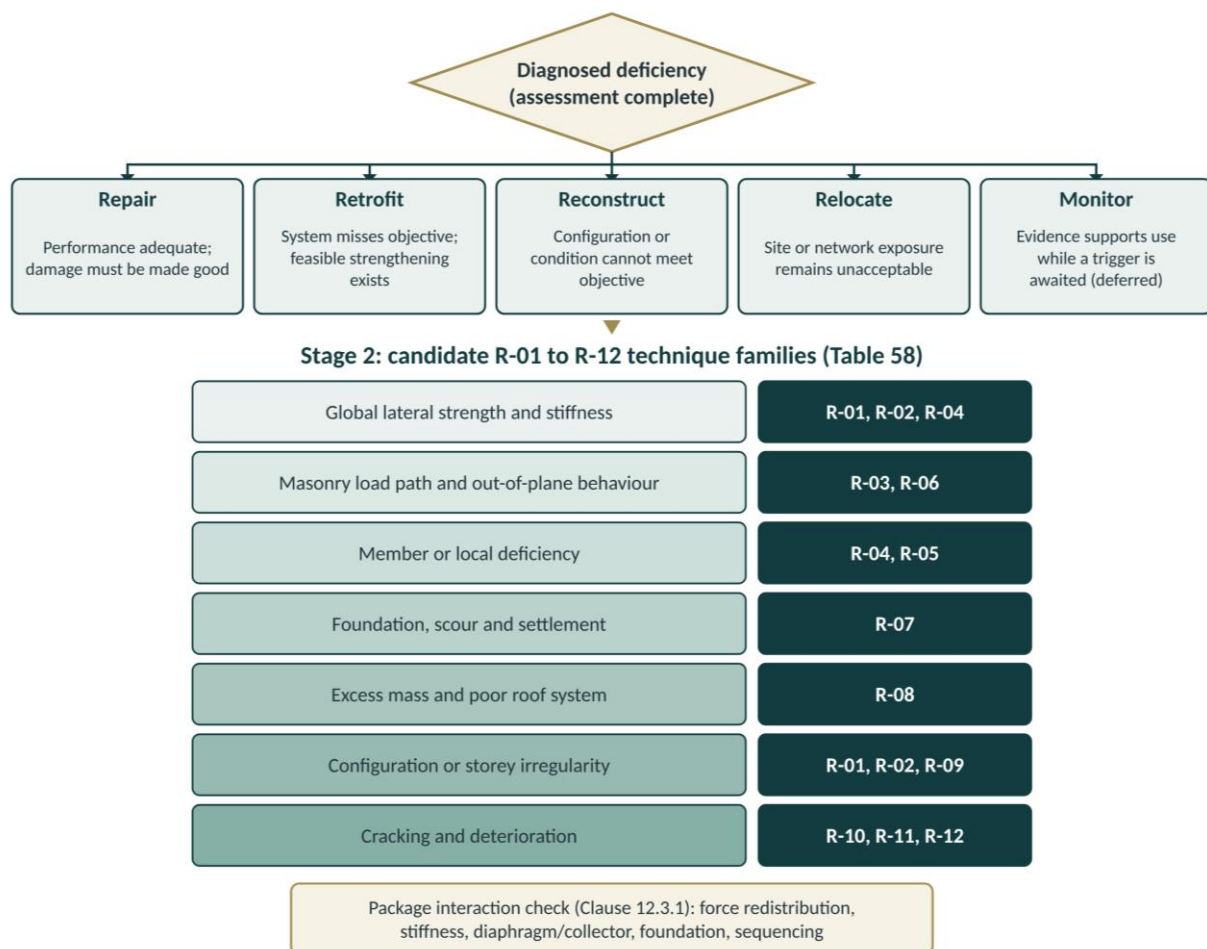


Figure 13.2 Intervention selection: two-stage decision tree

13.5 Package interaction

13.5.1 Measures shall be assembled into a coordinated package and checked for force redistribution, stiffness, period and torsion, diaphragm and collector demand, foundation actions, movement compatibility, temporary stability and construction sequence.

Table 13.4 Package interactions to close before the design is issued

Interaction	Question to close
Added walls or bracing with the existing frame	Does added stiffness attract force or create a new irregularity or collector demand?
Ties and confinement in weak masonry	Can anchors and confining elements transfer load without local brittle failure?
Local strengthening of members	Does strengthening move the critical failure elsewhere?
Foundation work	How are loads supported and movements controlled during transfer?
Roof replacement	Are wind, thermal, fire, acoustic, water and diaphragm functions all restored?
Repair measures	Is the cause of deterioration controlled and the future condition addressed?

14 Standard Details

14.1 Status and use

14.1.1 The identifiers below provide one stable vocabulary for recurring resilience details. An identifier does not make a detail universally applicable and does not replace project-specific calculation, dimensioning, material selection, specification, review and construction control.

14.1.2 Each project detail sheet shall state its status, design intent, project-specific design detail, or as-built record, and shall be issued for construction only when the design is complete, checked and coordinated.

14.2 Content of a project detail sheet

Table 14.1 Content of a project detail sheet

Field	Content
Identity and status	Identifier, title, revision, date, status, and the project it belongs to.
Scope and limitations	Applicable systems and conditions, excluded conditions, required engineering inputs.
Design basis	Code and standard clauses, loads and actions, materials, exposure, service life, calculation reference.
Drawing content	Plans, sections and elevations as needed; dimensions, levels, materials, connections, interfaces and sequence.
Performance intent	The failure mechanism controlled and the load, water or service path maintained.
Specification links	Materials and products, preparation, workmanship, tolerances, protection, temporary works.
Verification	Design check, submittal, trial, inspection, test, hold and witness points, acceptance criteria.
Operation	Access, inspection, maintenance, deployment, replacement and event triggers.
Sign-off	Designer, checker, independent reviewer where required, AHJ and owner acceptance.

14.3 Detail schedule

Table 14.2 Standard detail schedule

Ref	Detail	Performance intent	Principal engineering inputs
D-01	Soft- or weak-storey correction	Prevent concentration of drift, instability and brittle failure at a discontinuous storey.	Deficiency and model; performance objective; member, material and foundation data; architectural and service constraints.
D-02	Confined masonry tie-column and tie-beam system	Create a complete confined-masonry system with controlled panels, openings and load transfer.	Adopted masonry and seismic clauses; wall layout and openings; unit, mortar, concrete and reinforcement properties; diaphragm and foundation.

Ref	Detail	Performance intent	Principal engineering inputs
D-03	Through-wall tie and restraint for unreinforced masonry	Restrain masonry out of plane and transfer force without local pull-out or wall delamination.	Wall material, thickness, bond and condition; diaphragm type; demand; corrosion and fire exposure.
D-04	Diaphragm-to-wall anchorage	Provide a positive, ductile and inspectable force path between diaphragm and supporting wall or frame.	Diaphragm material and edge; wall condition; demand and tributary length; collector and chord.
D-05	Parapet and gable restraint	Prevent out-of-plane collapse or falling debris over occupied and egress areas.	Geometry, material and condition; wind and seismic actions; support substrate; roof movement; drainage.
D-06	Non-structural component restraint	Prevent falling, sliding and service rupture while preserving required function.	Component mass, geometry and importance; support and location; demand; movement; equipment requirements.
D-07	Foundation and scour protection	Maintain foundation support and load transfer under the computed scour condition.	Hydraulic and scour study; bed and ground levels; soil and rock; foundation survey and loads; debris.
D-08	Elevated services and critical plant	Keep critical systems operable and safely accessible above the design flood condition.	Design flood level; equipment mass, function and environmental limits; support and anchorage; service routes.
D-09	Flood-damage-resistant lower-zone materials	Limit hazardous damage, contamination retention and recovery time below the design level.	Flood mechanism, duration and contaminants; wall and floor assemblies; drying access; cleaning regime.
D-10	Flood openings for wet floodproofing	Limit damaging hydrostatic differentials while allowing controlled entry and drainage.	Adopted flood standard; design level; enclosure geometry; structural walls; debris and blockage.
D-11	Permanent or deployable flood barrier	Exclude water to the approved level without creating hidden structural or operational failure.	Design head, waves and debris; wall, slab and foundation; leakage criterion; closure time and staffing.
D-12	Campus drainage and exceedance route	Collect, convey, store and safely route runoff through design and blocked states.	Approved rainfall and hydrology; survey and catchments; inlets, network and storage; tailwater; sediment.
D-13	Roof uplift load path	Transfer local and global wind actions from the roof covering through walls and frames to the foundation.	Wind basis and zones; roof system, members and substrate; enclosure state; corrosion and fire; foundation.
D-14	Profiled-sheet roof fastening	Prevent pull-over, pull-out, local sheet failure and progressive loss in each pressure zone.	Approved roof product and profile; manufacturer data; pressures, zones and tributary area; purlin material.
D-15	Verandah, canopy and overhang bracing	Control high local uplifts, torsion and weak attachment of exposed projecting elements.	Geometry; local wind pressures; members and connections; wall, frame and foundation substrate; drainage.

Ref	Detail	Performance intent	Principal engineering inputs
D-16	Opening protection and frame anchorage	Maintain the assumed enclosure state and protect occupants from pressure, debris and rain.	Wind and debris criterion; opening, frame and substrate; accessibility; deployment and storage.
D-17	Benched and drained cut slope	Provide stable geometry with controlled water and erosion management for the project ground model.	Geotechnical models and parameters; geometry; groundwater and rainfall cases; erosion; access; vegetation.
D-18	Drained retaining structure	Retain ground while controlling water pressure, global stability and long-term drainage.	Ground model; earth, water and seismic actions; wall system and material; foundation; surcharge; exposure.
D-19	Cover, drip and water-shedding interface	Discharge water clear of vulnerable faces, joints, reinforcement and interior assemblies.	Assembly geometry and materials; rainfall and wind exposure; movement; drainage; cleaning access.
D-20	Egress door and external route	Provide usable, accessible and protected escape in normal and hazard states.	Adopted fire, egress and accessibility rules; occupancy; hardware; wind and flood exposure; lighting.
D-21	Emergency and seismic gas shut-off	Limit gas release and post-event ignition while retaining controlled isolation and restart.	Gas system; authority and fire requirements; seismic demand; equipment and pipe layout; detection.

The parametric concept plates for D-01 to D-21 follow. Each plate is a recognition aid for the detail's performance intent, interfaces and engineering inputs; it is not a construction detail and does not replace project-specific design (Clause 14.1.1). They are presented as Figures 14.1 to 14.2.1.

D-01 Soft / weak-storey mechanism elimination

PARAMETRIC CONCEPT

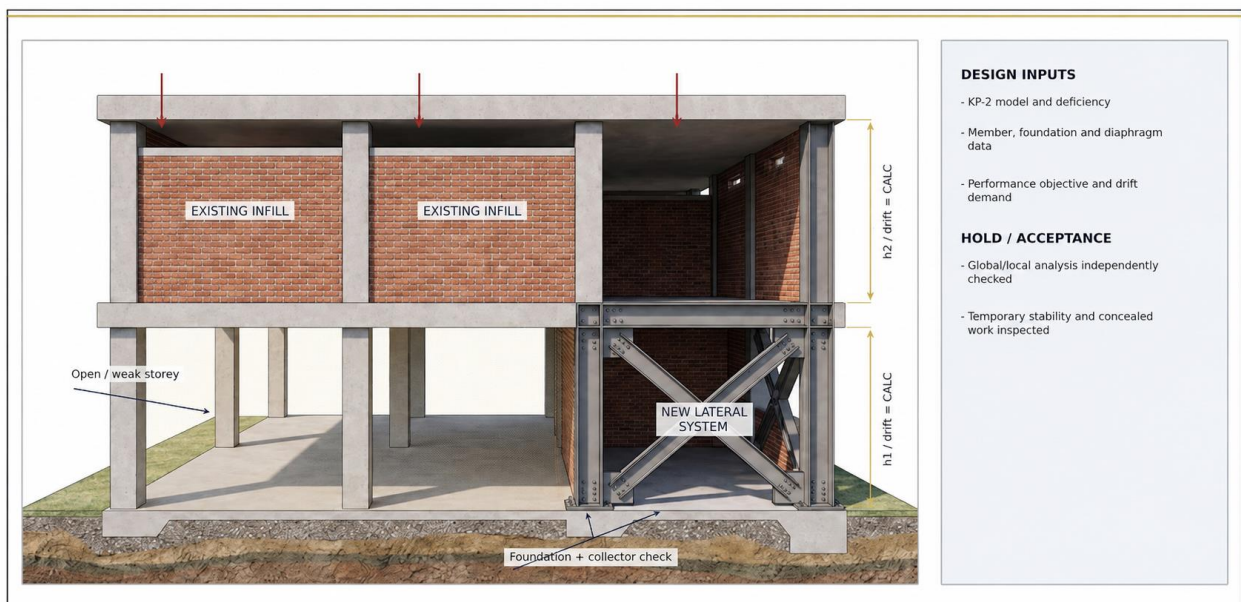


Figure 14.1 D-01: Soft- or weak-storey correction

D-02 Confined-masonry tie-column and tie-beam system

PARAMETRIC CONCEPT



Figure 14.2 D-02: Confined masonry tie-column and tie-beam system

D-03 URM through-wall tie and restraint

PARAMETRIC CONCEPT

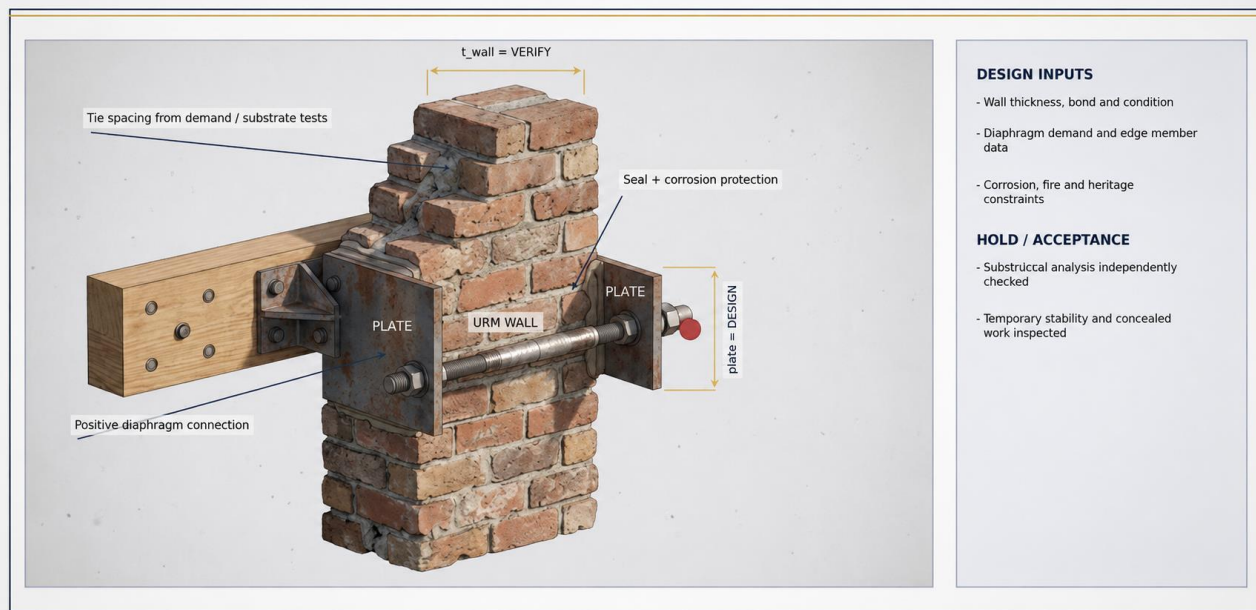


Figure 14.3 D-03: Through-wall tie and restraint for unreinforced masonry

D-04 Floor-to-wall ledger connection

PARAMETRIC CONCEPT

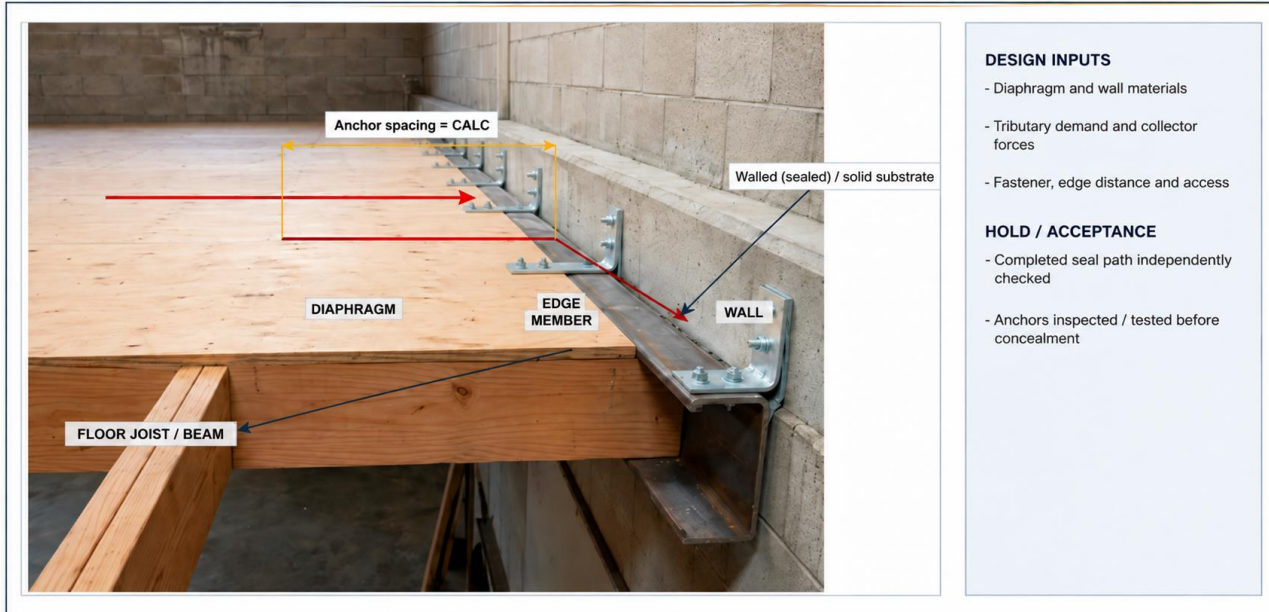


Figure 14.4 D-04: Diaphragm-to-wall anchorage

D-05 Parapet and gable restraint

PARAMETRIC CONCEPT

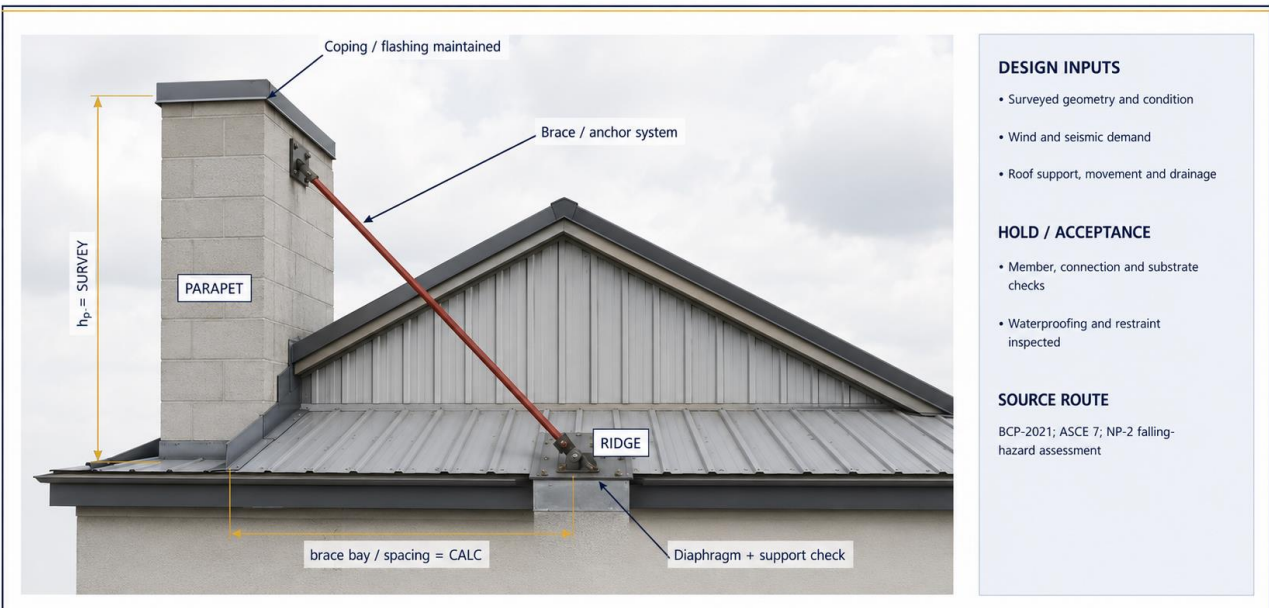


Figure 14.5 D-05: Parapet and gable restraint

D-06 Nonstructural component restraint

PARAMETRIC CONCEPT

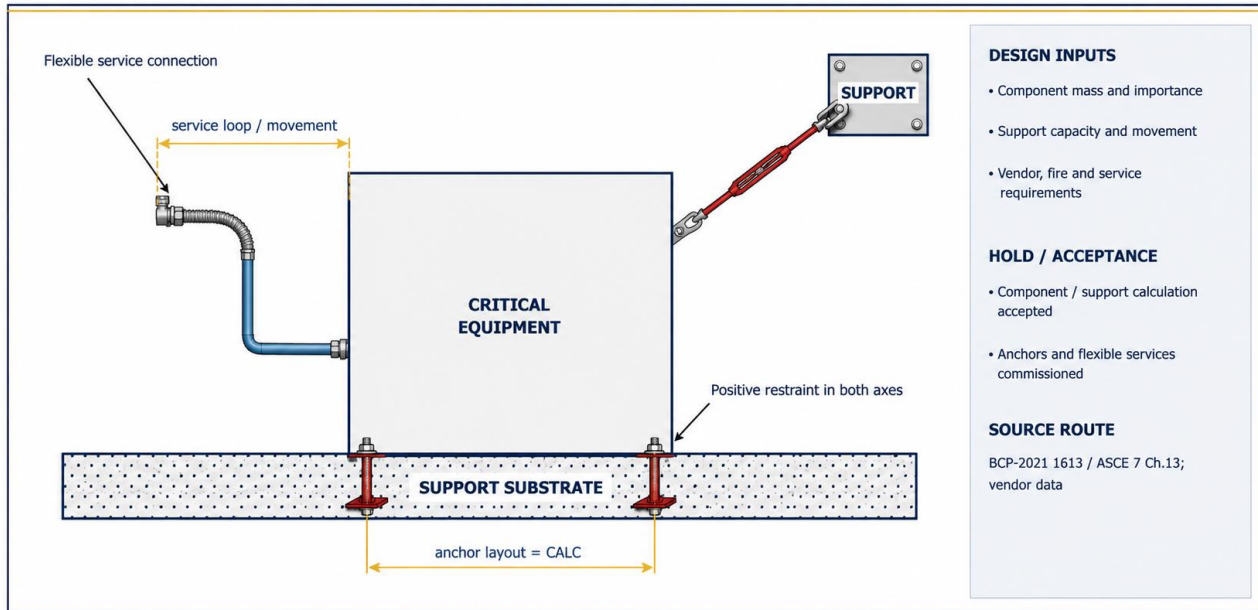


Figure 14.6 D-06: Non-structural component restraint

D-07 Foundation and scour resilience

PARAMETRIC CONCEPT

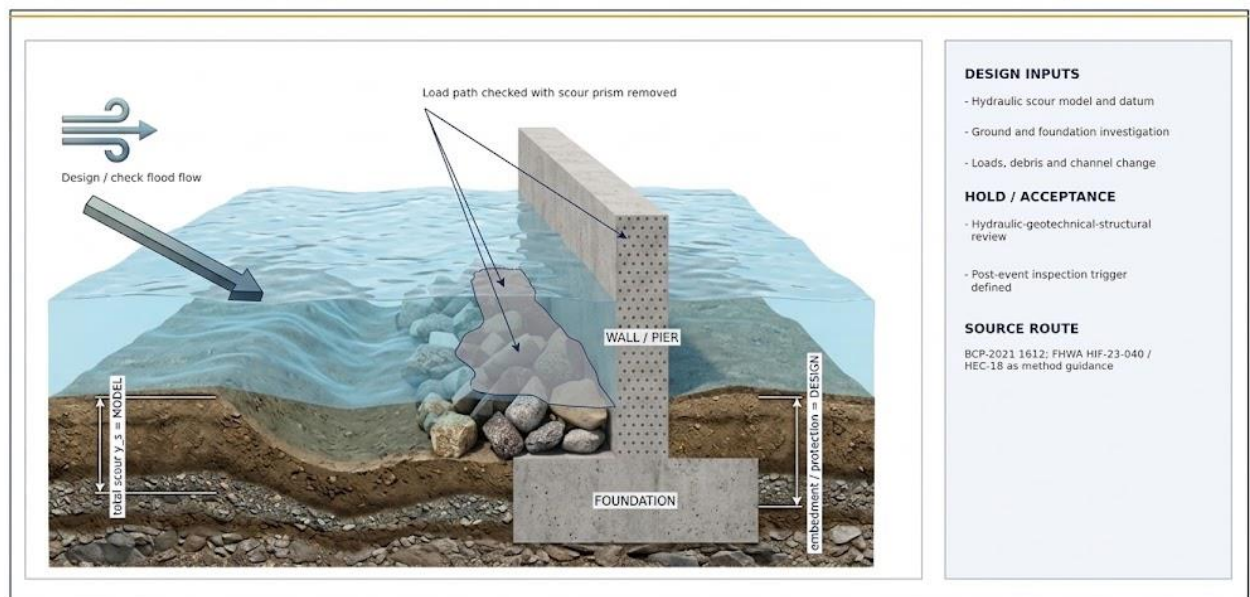


Figure 14.7 D-07: Foundation and scour protection

D-08 Elevated services and critical plant

PARAMETRIC CONCEPT

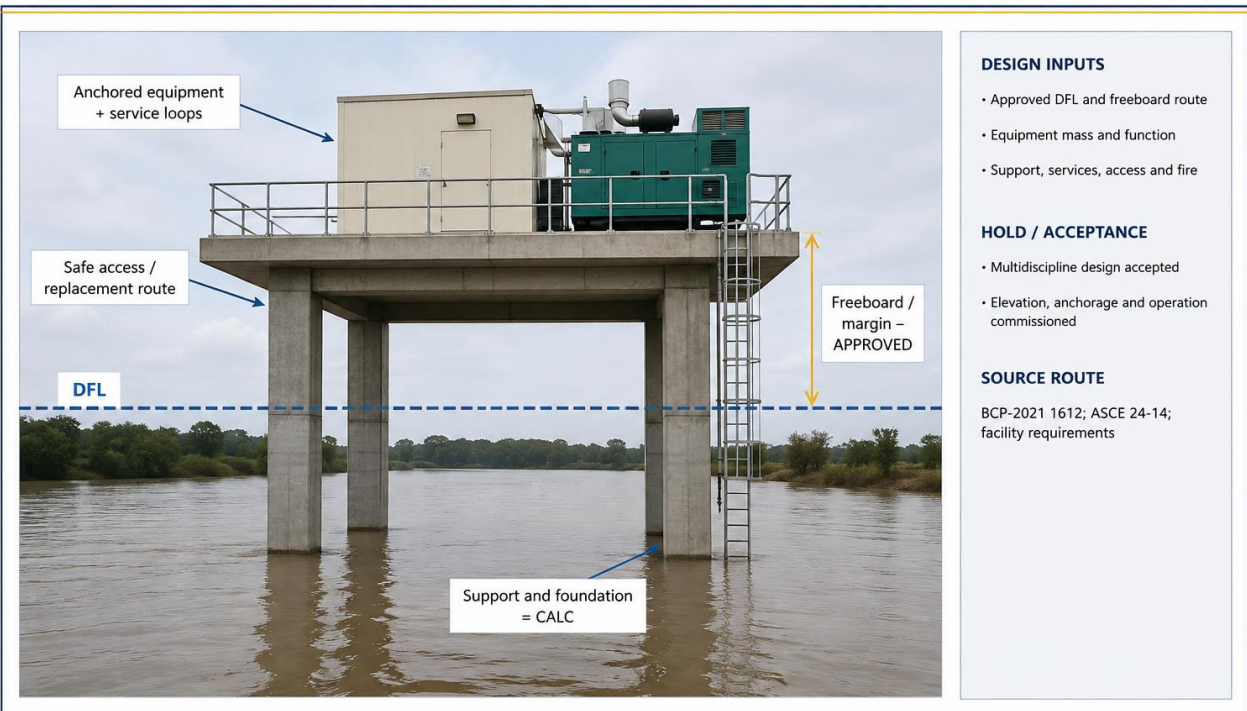


Figure 14.8 D-08: Elevated services and critical plant

D-09 Flood-damage-resistant lower-zone materials

PARAMETRIC CONCEPT

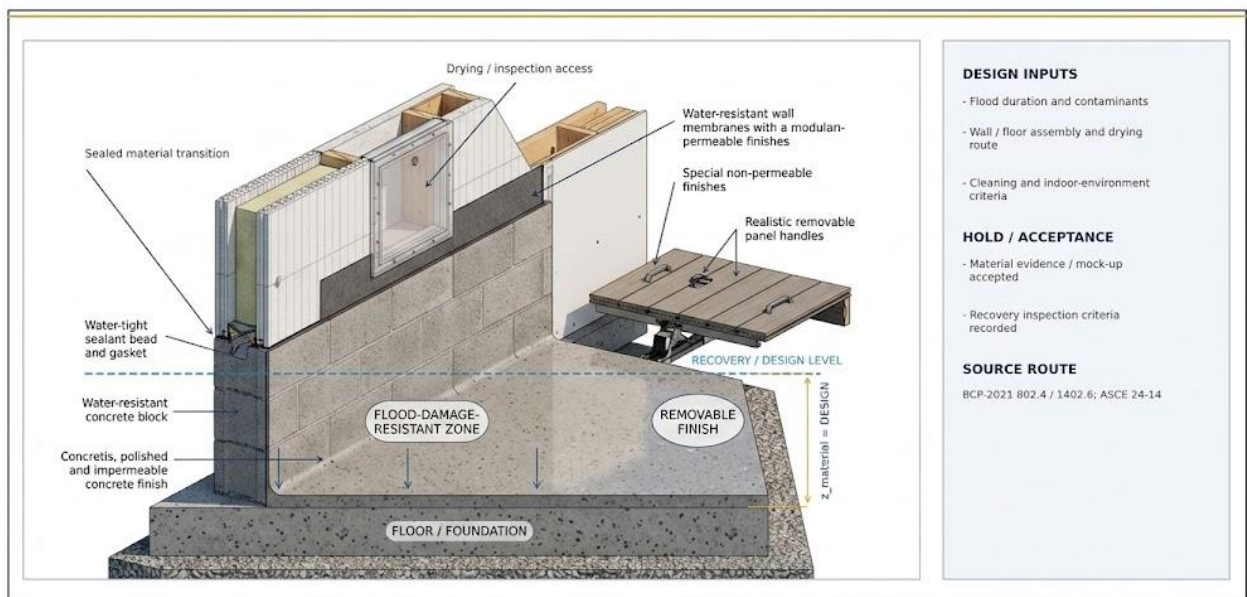


Figure 14.9 D-09: Flood-damage-resistant lower-zone materials

D-10 Flood openings and wet floodproofing

PARAMETRIC CONCEPT

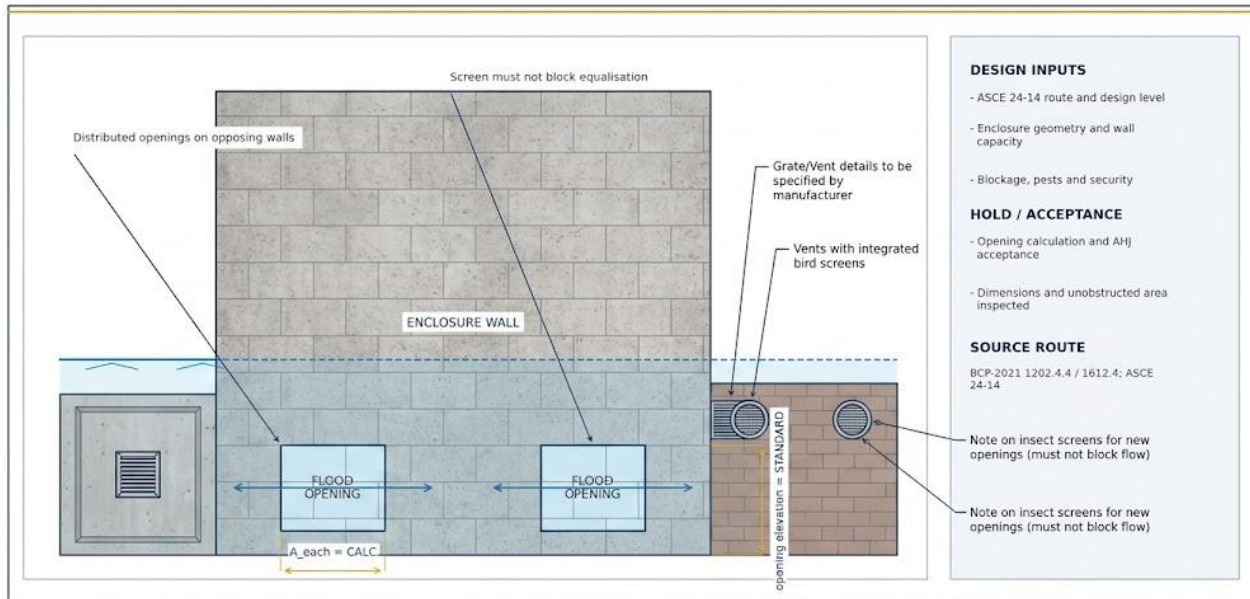


Figure 14.10 D-10: Flood openings for wet floodproofing

D-11 Permanent or deployable flood barrier

PARAMETRIC CONCEPT

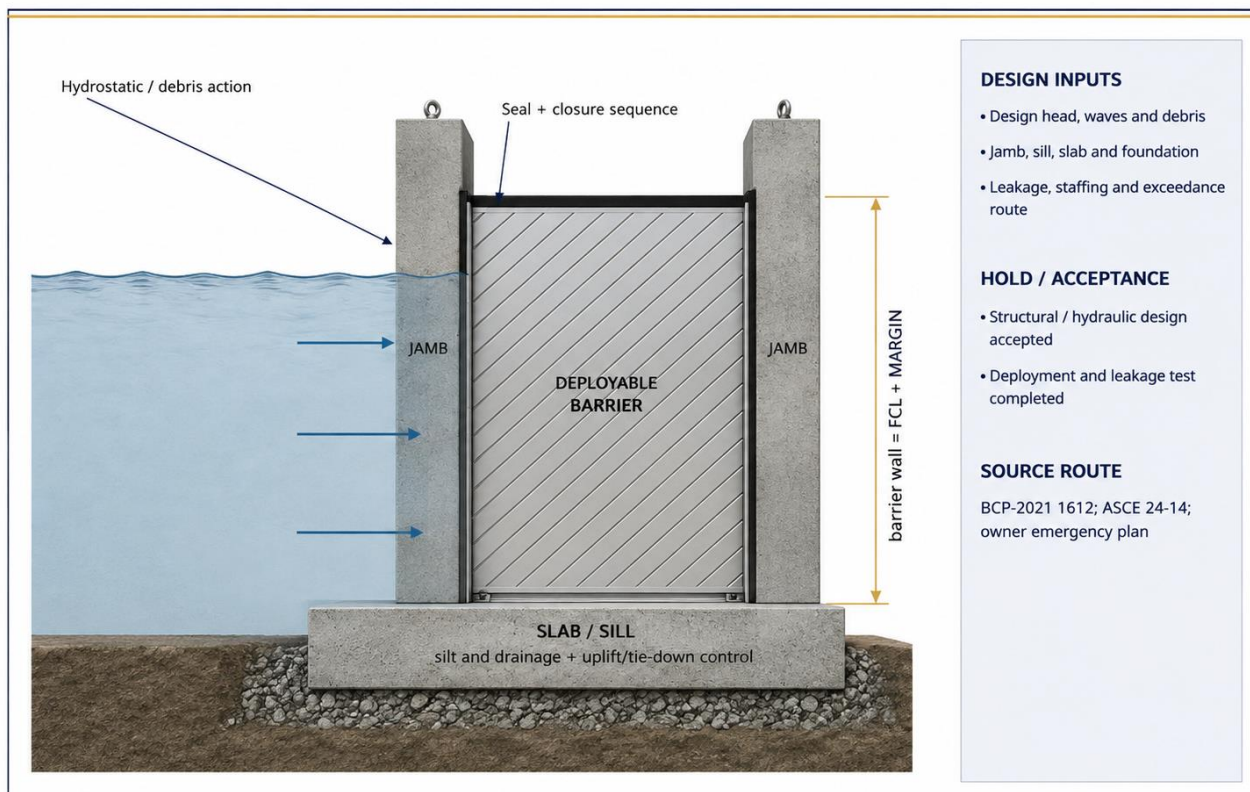
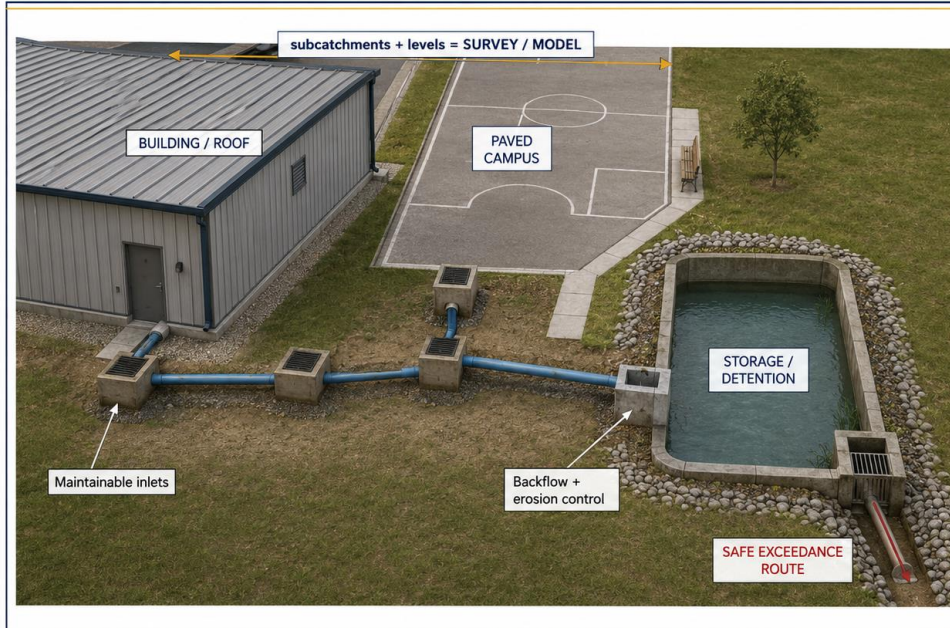


Figure 14.11 D-11: Permanent or deployable flood barrier

D-12 Campus drainage and safe exceedance

PARAMETRIC CONCEPT



DESIGN INPUTS

- Survey and approved rainfall basis
- Catchments, inlets, storage and tailwater
- Blockage, debris and neighbour impacts

HOLD / ACCEPTANCE

- Hydrology / hydraulic model checked
- Levels, hidden works and flow route verified

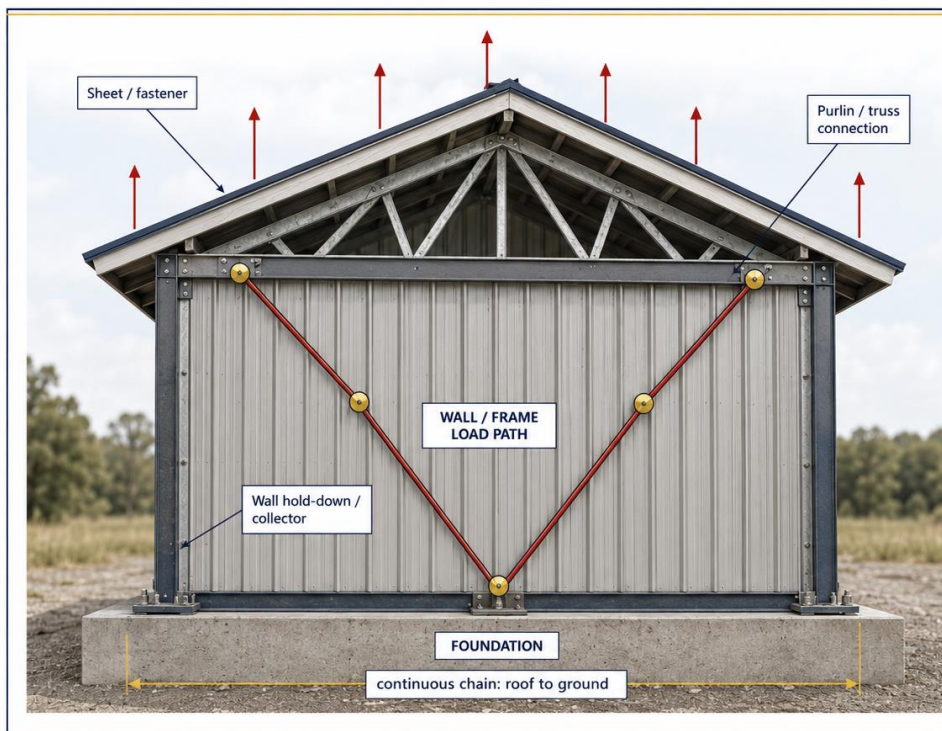
SOURCE ROUTE

BCP-2021 1611; Chapter 3 climate design basis

Figure 14.12 D-12: Campus drainage and exceedance route

D-13 Roof-uplift continuous load path

PARAMETRIC CONCEPT



DESIGN INPUTS

- BCP wind speed and pressure zones
- Roof, wall and foundation systems
- Enclosure, exposure and corrosion

HOLD / ACCEPTANCE

- Every connection mode calculated
- Hidden load-path interfaces inspected

SOURCE ROUTE

BCP-2021 1609.3 / ASCE 7-16; Chapter 8

Figure 14.13 D-13: Roof uplift load path

D-14 Profiled-sheet roof fastening

PARAMETRIC CONCEPT

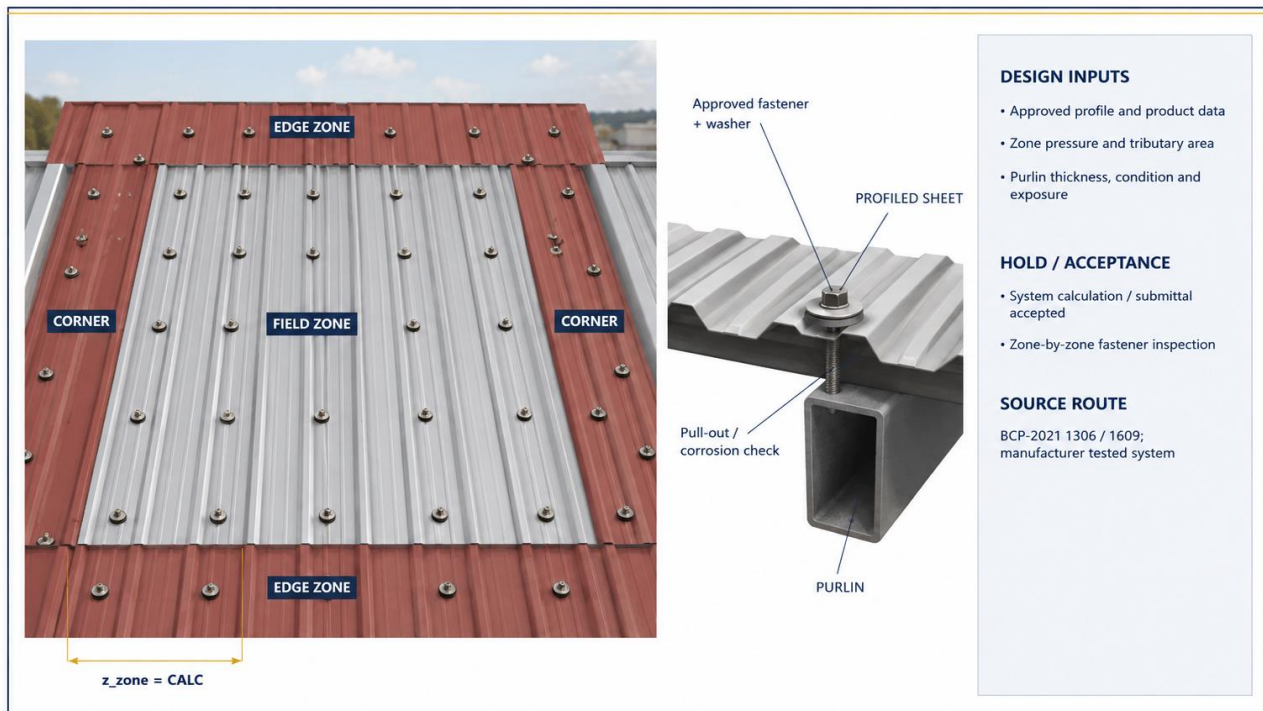


Figure 14.14 D-14: Profiled-sheet roof fastening

D-15 Verandah, canopy and overhang bracing

PARAMETRIC CONCEPT



Figure 14.15 D-15: Verandah, canopy and overhang bracing

D-16 Opening protection and frame anchorage

PARAMETRIC CONCEPT

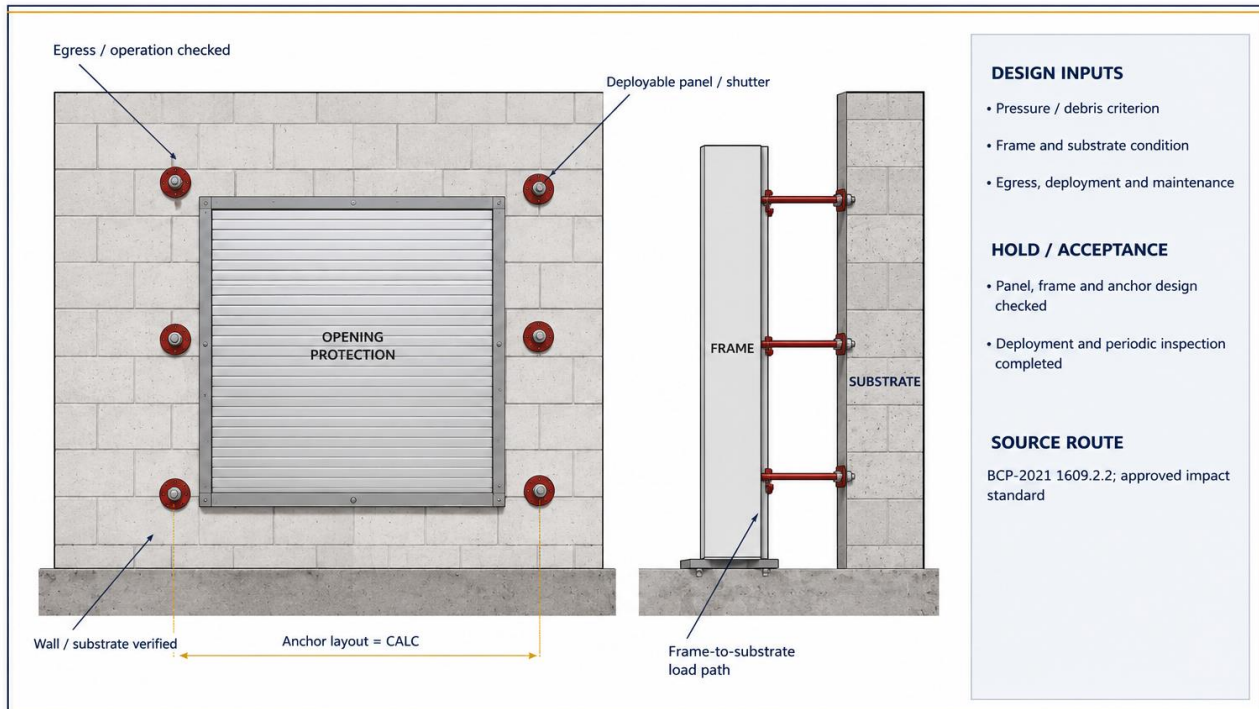


Figure 14.16 D-16: Opening protection and frame anchorage

D-17 Benched and drained cut slope

PARAMETRIC CONCEPT

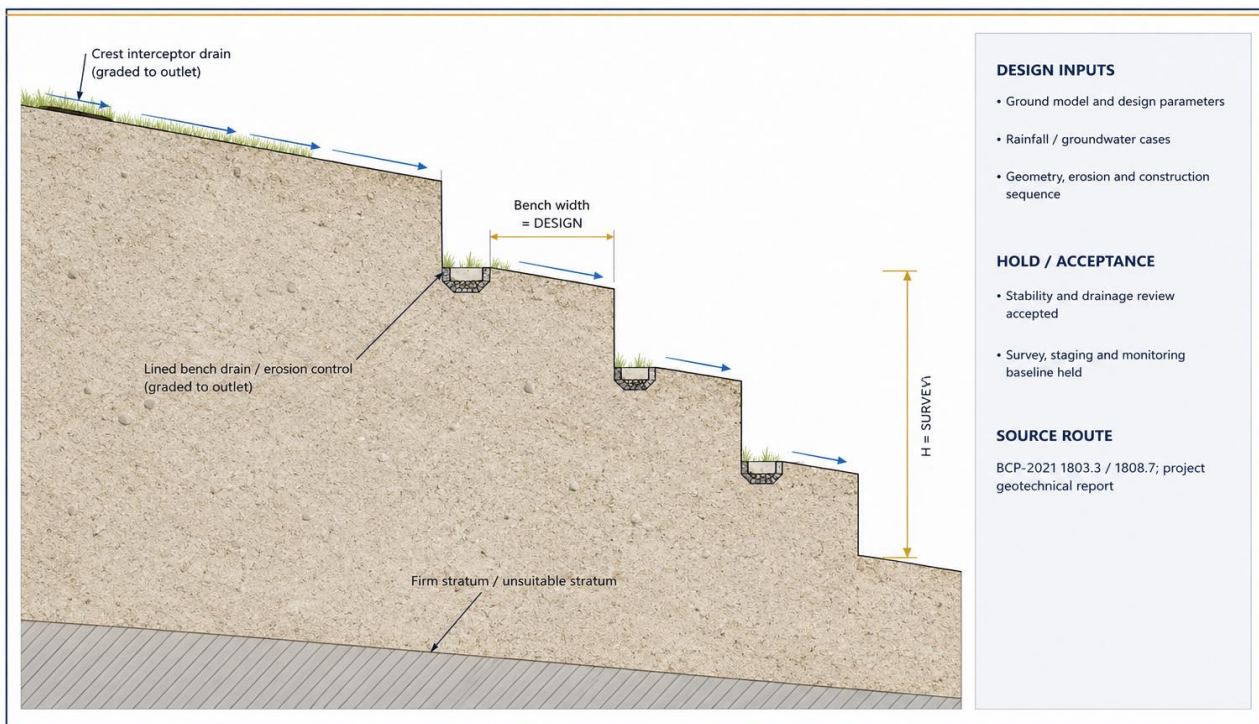


Figure 14.17 D-17: Benched and drained cut slope

D-18 Drained retaining structure

PARAMETRIC CONCEPT

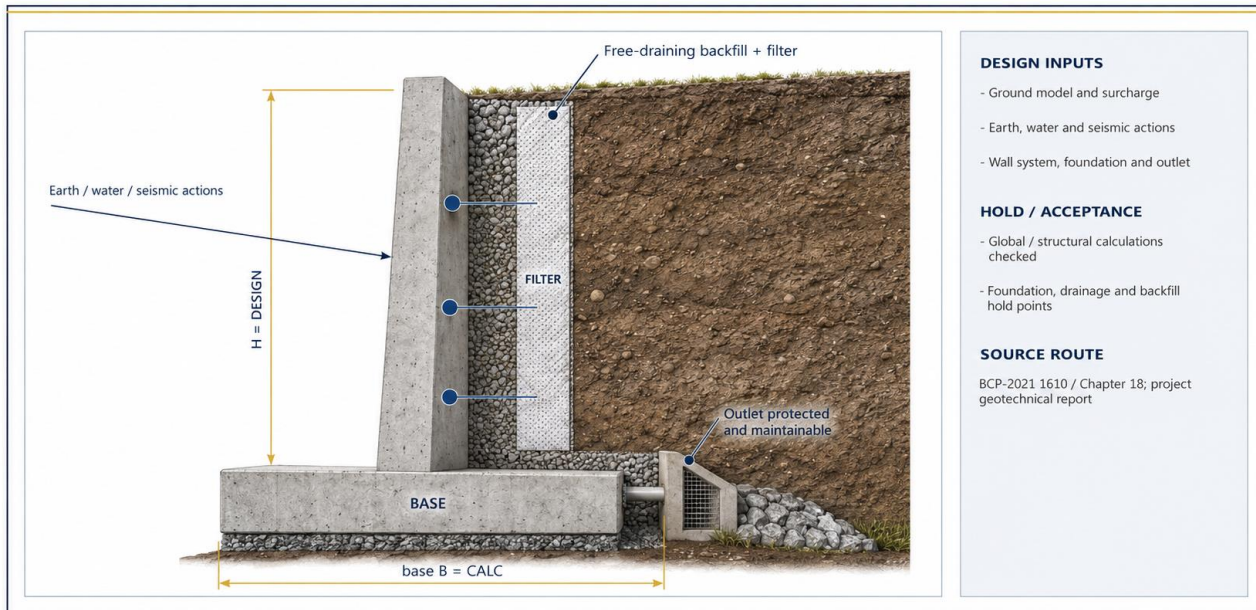


Figure 14.18 D-18: Drained retaining structure

D-19 Cover, drip, throat and water shedding

PARAMETRIC CONCEPT

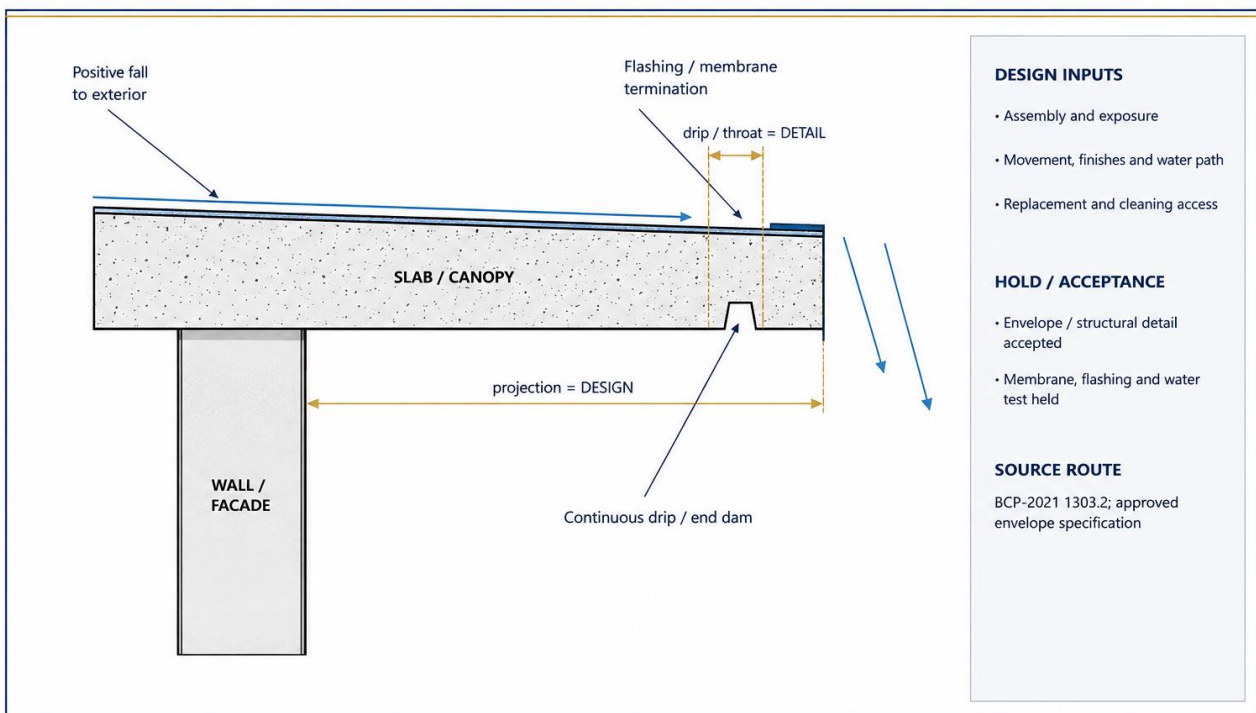


Figure 14.19 D-19: Cover, drip, throat and water-shedding interface

D-20 Egress door and external route

PARAMETRIC CONCEPT

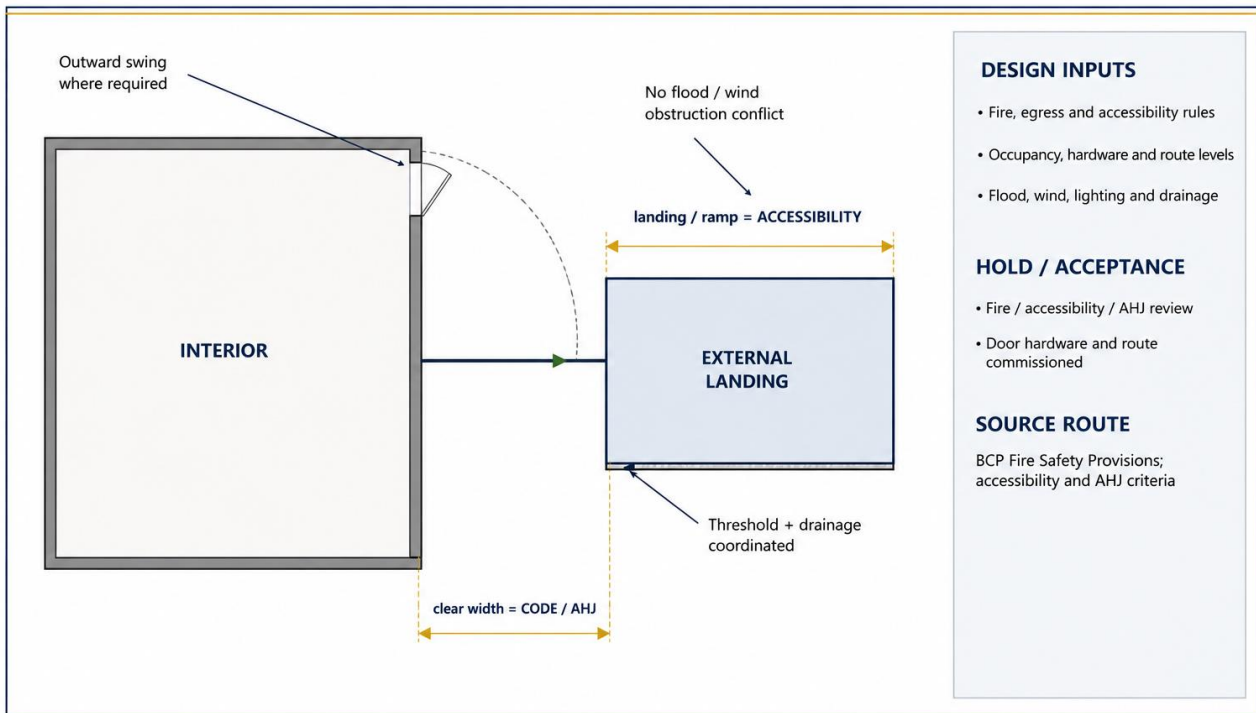


Figure 14.20 D-20: Egress door and external route

D-21 Emergency gas shutoff and restraint

PARAMETRIC CONCEPT

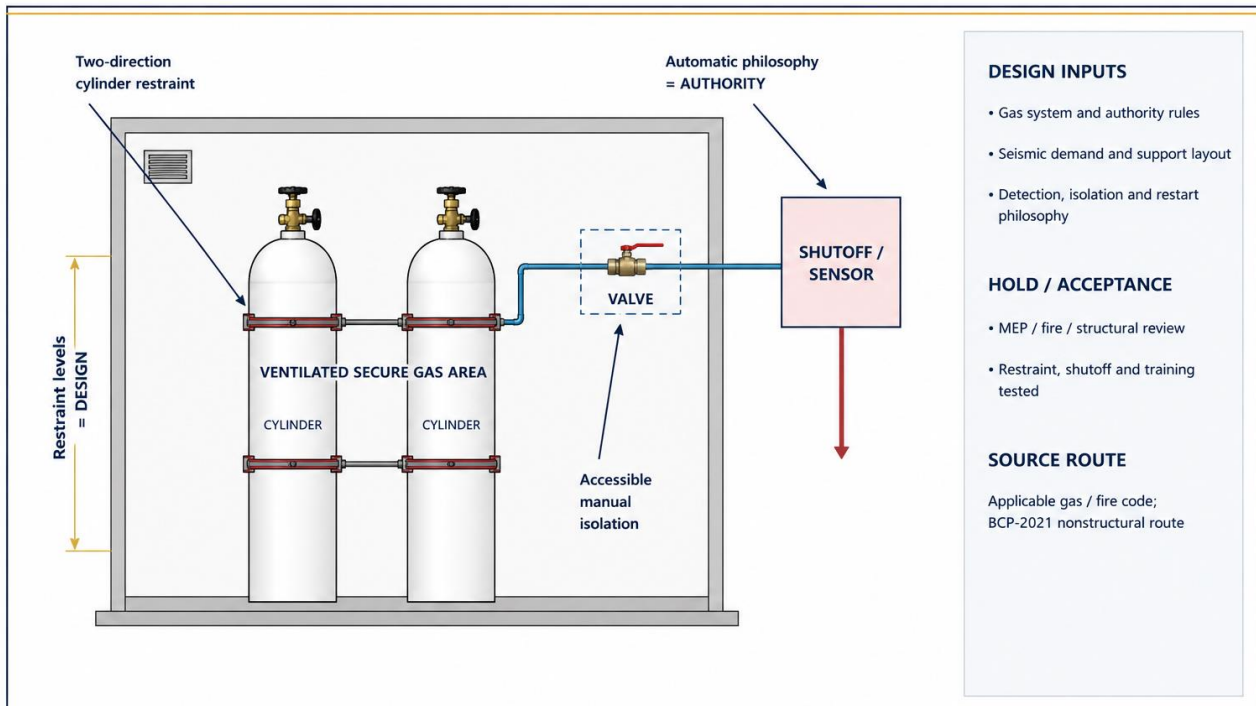


Figure 14.21 D-21: Emergency gas shut-off and restraint

15 Compliance, Review and Certification

15.1 Assurance objective

15.1.1 A resilience claim shall be supported by a closed evidence chain from mandate and source, through calculation, drawing, review and construction verification, to commissioning and the retained record.

15.1.2 Certification shall be completed at the project gate to which the evidence relates. Design compliance shall be certified only after the design; its review and the required approvals are closed. Construction and handover conformity shall be certified only after the relevant inspections, tests, as-built information and commissioning are complete. Neither certificate replaces the underlying evidence. Figure 15.1 shows the evidence chain each requirement follows.

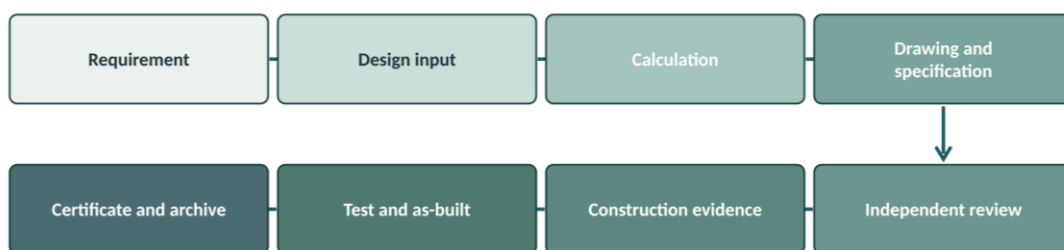


Figure 15.1 Compliance evidence chain

15.2 Clause-to-evidence register

Table 15.1 Clause-to-evidence register fields

Field	Entry
Requirement reference	Code, guideline, owner or AHJ clause or decision.
Requirements and intent	Concise statement of the requirement and its performance intent.
Applicability	Applicable; not applicable with reason; or clarification required.
Responsible lead	Named discipline, person or organization.
Design response	Calculation, drawing, specification or operational control.
Evidence reference	Controlled file, revision, and sheet, section, test or record.
Reviewer and status	Reviewed, comment, closed, or not accepted.
Approval and residual risk	AHJ and owner decision, and any remaining limitation.

15.2.1 An entry marked "Not applicable" or "Not material" shall state why. A blank entry shall not be read as reviewed, not applicable, not material or compliant. Color alone shall not be used to communicate these statuses; the text itself carries the decision.

15.2.2 The register shall distinguish design compliance from construction conformity. An approved drawing is evidence of design intent, not evidence that the work was built correctly.

15.3 Review levels

Table 15.2 Review levels, when each is used, and independence

Level	When used	Independence and output
Self-check and discipline check	All calculations, drawings and schedules	A named checker other than the preparer where practicable; signed check and closed comments.
Multidisciplinary coordination review	Interfaces among structure, site, architecture, services, fire, accessibility and operations	Coordinated drawings and an interface register.
Independent technical review	High consequences, unusual method, major strengthening, sensitive site, or owner or AHJ requirement	A reviewer not responsible for the original design; independent calculations or method checks, and closure.
Institutional and AHJ review	Adoption, permit, alternative method or jurisdictional decision	Written decision, conditions and retained approval.

15.3.1 Drafting or software automation shall not alter a structural equation, coefficient, acceptance limit, dimension or material property. Every such change shall be reviewed by a competent structural engineer before issue.

15.4 Certification

Certification is completed in two controlled stages, each for a named facility and a controlled revision. The design stage is certified before construction; construction and handover conformity is certified after installation, verification and commissioning. This keeps the certification gates aligned with the delivery stages of Table 4.1.

15.4.1 The Design Compliance Certificate records the design basis, criteria, calculations, drawings, deviations, independent review and residual design risks. It is signed at the close of the design and review gate and before construction begins.

15.4.2 The Construction and Handover Conformity Certificate records submittals, inspections and tests, non-conformance closure, as-built information, commissioning, training and residual operational risks. It is signed after construction verification and commissioning are complete. It does not reopen the design compliance decision, and design compliance does not evidence construction conformity.

Table 15.3 Design compliance certificate, issued before construction

Field	Entry
Facility, blocks and project reference	
Owner, AHJ and permit reference	
Designer and PEC registration number	
Checker and independent reviewer	
Project scope and intervention class	

Field	Entry
Code, edition, appendices and amendments applied	
Facility classification and performance objectives	
Design horizons	
Climate datasets, scenarios and issue dates	
Rainfall, flow, flood and coastal values adopted	
Heat and other climate criteria adopted	
Seismic basis and climate-interaction checks	
Wind basis and climate-interaction checks	
Slope and ground basis and climate cases	
Details and revisions used	
Strengthening measures and design reference	
Clause-to-evidence register revision	
Deviations and AHJ and owner decisions	
Residual risks, monitoring and adaptation triggers	
Design issue status and date	
Designer, checker, reviewer and owner signatures	
Application tier under clause 2.5 and the reason for it	
Environmental screening determination under clause 2.4, with its reference and date	
Climate-appropriate material selection matrix under clause 11.6, completed for each principal element	
Heat criteria adopted under clause 10.4 and Table 10.4, and the compliance route used	
Gender equality and social inclusion evidence under clause 12.5, including the accessibility standard adopted and the disability-inclusive evacuation strategy	
Consent and safeguarding record under clause 4.5	

Table 15.4 Construction and handover conformity certificate, issued after commissioning

Field	Entry
Facility, blocks and project reference	
Approved design revision used for construction	

Field	Entry
Submittals, material and product approvals	
Inspection and test evidence	
Hold and witness point closure	
Non-conformance and approved deviation closure	
As-built drawings and records	
Commissioning and functional test records	
Training and operation and maintenance handover	
Residual operational risks and monitoring triggers	
Construction and handover issue status and date	
Contractor, supervisor, reviewer and owner signatures	

15.5 Residual risk

15.5.1 A residual-risk statement shall describe actual project limitations: the specific hazard, component or dependency retained, why it is retained, who or what is affected, the controls and monitoring applied, the trigger for further action, and the named acceptance. A standard paragraph shall not be used to transfer professional responsibility or to waive a governing safety requirement.

15.5.2 Where a climate allowance is adopted as zero, the design compliance certificate shall state whether that follows from evidence, code or AHJ direction, owner decision, or absence of defensible data, and shall record the resulting sensitivity and residual risk.

15.6 Construction conformity and handover

Table 15.5 Construction conformity controls and minimum evidence

Control	Minimum evidence
Submittals	Approved materials and products, calculations, certificates, installer qualification, method statements.
Survey and setting out	Levels, dimensions, locations, existing substrate condition and benchmarks verified before work.
Hold and witness points	Inspection request, responsible reviewer, acceptance criteria and release record.
Trials and tests	Approved procedure, sample and location, result, acceptance, and disposition of failure.
Non-conformance	Description, containment, cause, technical disposition, approval and closure.
As-built record	Installed dimensions, materials and products, deviations, photographs, test records.
Commissioning	Functional test under normal, degraded and emergency modes; training; defects and closure.
Handover	Operation and maintenance information, inspections, spares, monitoring baseline, triggers, contacts and update cycle.

15.7 Final issue checklist

- Applicability, code and AHJ basis, appendices, editions and approvals are recorded.
- Every climate value and transformation has a primary source and a calculation record.
- The site and every material hazard and compound mode is closed or carried as an explicit residual risk.
- Structural calculations and any change to a formula or value have been reviewed by a competent engineer.
- Detail revisions, drawings, specifications and inspection hold points are coordinated.
- Environmental measures do not conflict with safety, resilience, clinical or learning function, or operations.
- Independent and institutional comments are closed with traceable evidence.
- Installed work, tests, commissioning and as-built records support the design claim.
- Residual risks, monitoring triggers and responsible owners are explicit.
- The application tier under clause 2.5 is recorded, and no requirement of the tier has been reduced to fit a budget or a programme date.
- The environmental screening determination under clause 2.4 has been obtained and its conditions are carried into the design and the specification.
- Materials and build-ups have been selected and recorded against the five tests at clause 11.1.2, and the selection matrix at clause 11.6 is complete.
- The indoor heat criteria at clause 10.4 and Table 10.4 are met by the passive design before mechanical cooling is relied upon.
- Gender equality and social inclusion requirements at clause 12.5 are met and evidenced, including the accessibility standard adopted, sanitation provision, and the disability-inclusive evacuation strategy.
- Consent, safeguarding and personal-data requirements at clause 4.5 are satisfied for every record and image collected or published.
- For a health facility, the Hospital Safety Index assessment under clause 12.3.2 is recorded and its lowest-scoring modules are addressed or carried as residual risk.
- Each certificate is signed only for the controlled package to which it relates and within each signatory's authority.

Annex A Climate Design Basis Record

One record is completed for each design variable to which a climate allowance is applied, and for each variable for which an allowance was considered and not adopted.

Table A.1 Climate design basis record

Field	Entry
Asset, system and decision	
Responsible designer and reviewer	
Design horizon and reason	
Baseline variable, value, units, location and period	
Baseline source and controlled file reference	
Projection dataset, issue, scenario or percentile, spatial scale	
Climate variable and adopted change	
Transformation from climate variable to design input	
Calculated design input or action, and units	
Central, upper and lower sensitivity, and effect on the decision	
Low-regret measures and adaptation trigger	
Limitations and residual risk	
Calculation or model reference and revision	
Designer, checker and independent reviewer closure	
Owner and AHJ decision where applicable	

Annex B Clarification and Deviation Records

B.1 Technical clarification

Table B.1 Technical clarification record

Field	Entry
Reference, date, originator and discipline	
Affected clause, value, document and revision	
Question, and why a decision is needed	
Available evidence and controlled references	
Proposed interpretation and options	
Safety, climate, cost, program and approval impact	
Decision authority and response	
Required document and calculation updates	
Reviewer and closure reference	

B.2 Deviation

Table B.2 Deviation record

Field	Entry
Reference, date and originator	
Requirement and its source authority	
Reason and proposed alternative	
Evidence and calculations	
Effect on safety, function, climate performance and whole life	
Compensating measures and residual risk	
Designer, checker and independent review	
Owner and AHJ decision and conditions	
Updates to issued documents, certificate and operations	

Annex C Project Detail Register

One row is completed for each detail developed for the project.

Table C.1 Project detail register

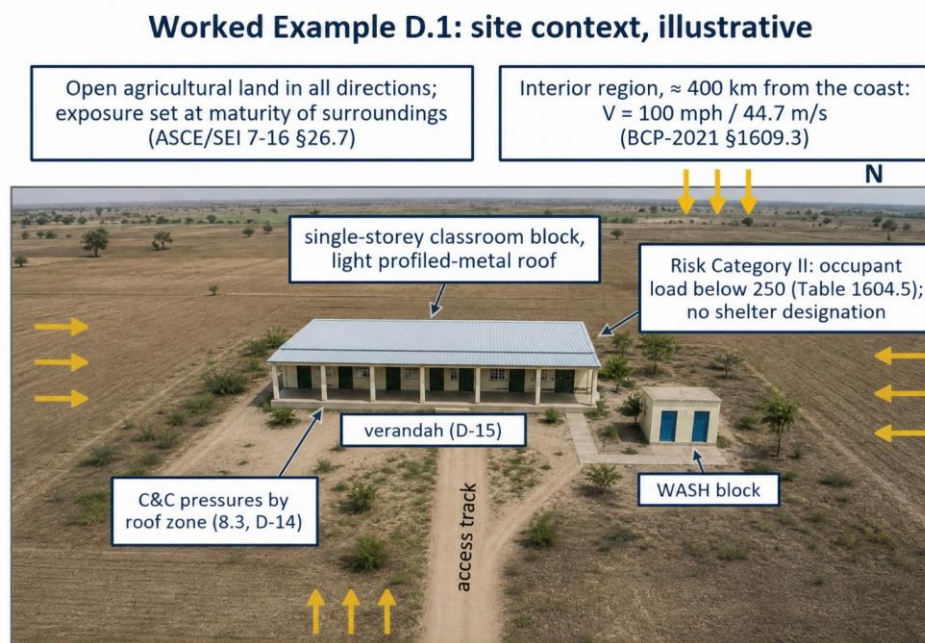
Ref	Project detail title	Design calculation	Drawing revision	Specification	Checker	Issue status
D-01						
D-02						
D-03						
D-04						
D-05						
D-06						
D-07						
D-08						
D-09						
D-10						
D-11						
D-12						
D-13						
D-14						
D-15						
D-16						
D-17						
D-18						
D-19						
D-20						
D-21						

Annex D Worked Examples

The examples below illustrate the application of Chapters 3, 8 and 13. All inputs are assumed for illustration. They are not records of any facility and shall not be transferred to a project.

D.1 Establishing the wind design basis

A single-storey primary school with a lightweight profiled-metal roof is to be built on open agricultural land in central Punjab, approximately 400 km from the coast, on level terrain. Figure D.1 shows the site context.



Illustrative site plan for Worked Example D.1; assumed inputs, not a facility record.

Figure D.1 Site context for Worked Example D.1

Table D.1 Wind design basis, illustrative

Step	Determination	Basis
1	Assign the Risk Category from the code-determined occupant load, the presence of emergency treatment or surgery, and any designated shelter use. For this illustrative example the school has an occupant load of 180 and is not a designated shelter, giving Risk Category II. Risk Category is established first because the basic wind speed map is itself Risk Category dependent.	BCP-2021 §1604.5 and Table 1604.5
2	Read the basic design wind speed V for that Risk Category. Under BCP-2021 the basic design wind speed for Pakistan is 120 mph for coastal areas and 100 mph for all other areas. This illustrative example is an interior site, giving $V = 100$ mph (44.7 m/s).	BCP-2021 §1609.3 and §1609.3.1
3	Confirm the site is not in mountainous terrain or near a gorge, so that no site-specific determination of the wind speed is required.	BCP-2021 §1609.3
4	Determine exposure category from the surrounding ground roughness at maturity, not from the present condition of the site.	ASCE/SEI 7-16 §26.7

Step	Determination	Basis
5	Establish component and cladding pressures separately for field, edge and corner zones, and design the fastening to the zone in which each fastener sits.	ASCE/SEI 7-16 Chapter 30
6	Trace the uplift load path: sheet to fastener, fastener to purlin, purlin to truss, truss to wall, wall to foundation. Check each connection for its governing failure mode.	Clause 8.2.1

CAUTION

Common critical failure modes in this building type occur at the sheet-to-purlin and truss-to-wall connections. Increasing sheet gauge without checking the fasteners, the purlins and the wall anchorage may shift rather than eliminate the governing failure mode.

D.2 Recording a rainfall allowance

A campus drainage system is designed for a facility with a 40-year service life. The design team proposes an allowance on design rainfall intensity.

Table D.2 Climate allowance record, illustrative

Field	Illustrative entry
Design variable	1-hour rainfall depth for the 1-in-25-year event, used as input to the campus drainage model
Baseline value and source	Depth-duration-frequency value for the nearest long-record station, published by the national meteorological service; baseline period stated
Design horizon	2065, from the 40-year facility horizon set in the owner's brief
Dataset and scenario	Named projection dataset, emissions scenario and percentile, with issue date
Transformation	Allowance applied to the rainfall input; the drainage model is then re-run and the design outputs recomputed
Adopted value	The recomputed peak flow, inlet capacity and storage volume, not a percentage applied to the previously computed flow
Sensitivity	Central and upper cases run; the decision changes only above the upper case, so the central case is adopted with a monitored trigger
Residual risk	Exceedance route defined and kept clear; blockage case assessed; owner accepts the residual
Approval	Designer, checker and independent reviewer named; owner decision recorded

Figure D.2 shows where the allowance enters the calculation and the shortcut that is not permitted.

The allowance is applied to the model input; the design outputs are recomputed, never scaled

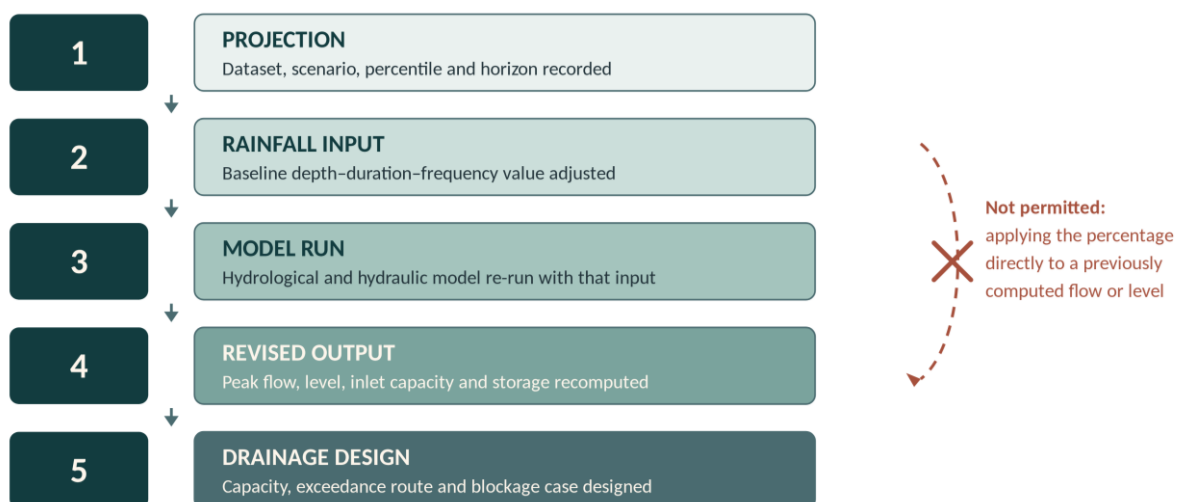


Figure D.2 Where a rainfall allowance enters the calculation

The record makes the allowance auditable. A reviewer can see which dataset was used, where the allowance entered the calculation, and what would have to change for the decision to change. An allowance expressed only as a percentage uplift on a final flow figure would satisfy none of those tests.

D.3 Comparing intervention with replacement

A two-storey concrete-frame block requires strengthening. Costs are assembled on the basis required by Clause 13.2.1 and discounted under Clause 13.2.4. Figure D.3 charts the comparison.

Table D.3 Whole-life cost comparison, illustrative

Item	Term	Amount (assumed)
Measured strengthening works at current rates	C_intervention	1.00 unit
Design, investigation, approval and supervision	C_intervention	0.14 unit
Decant and service continuity during the works	C_intervention	0.18 unit
Risk allowance	C_intervention	0.13 unit
Total intervention cost		1.45 unit
Replacement building of equivalent scope	C_replacement	2.45 unit
Demolition and disposal, less salvage	C_replacement	0.20 unit
Total replacement cost		2.65 unit
Ratio R		0.55

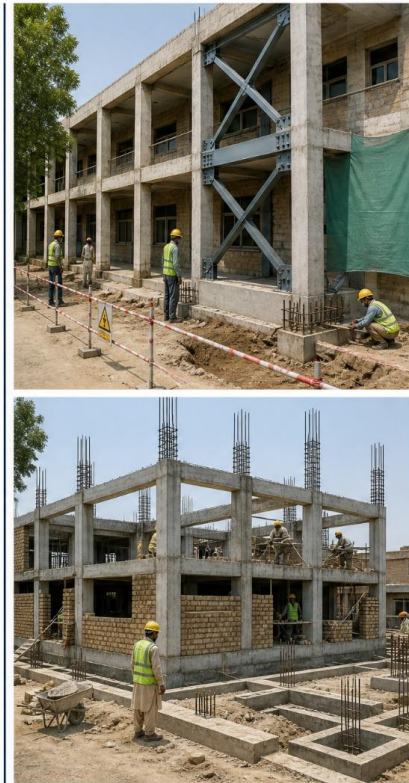
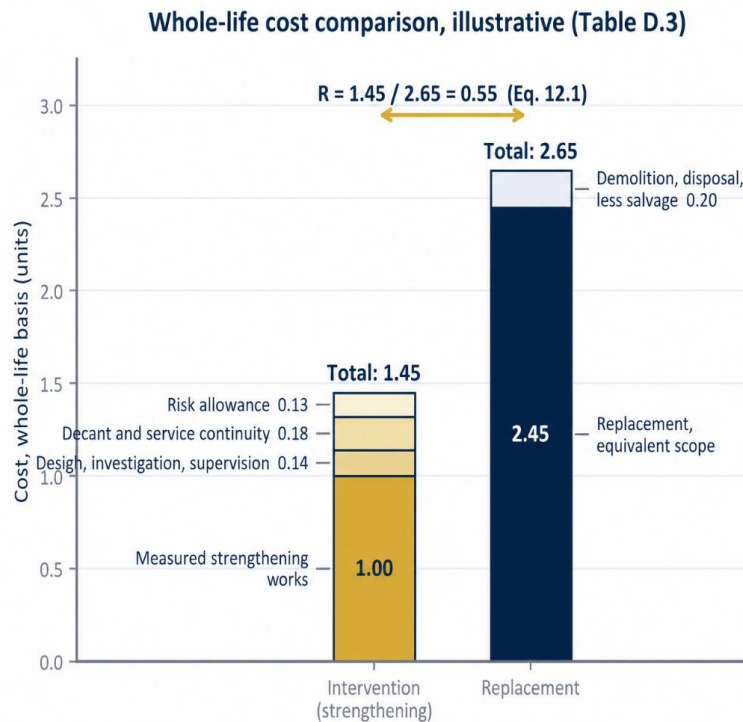


Figure D.3 Whole-life cost comparison (Table D.3)

The ratio is reported with its basis. Whether it is acceptable is a program policy determination under Clause 13.2.2, taken and recorded by the owner or financing institution. The design records that the strengthening addresses the identified deficiency but leaves the remaining components at their existing age and condition, whereas replacement delivers a full design life at 1.8 times the intervention cost.

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- 1) Pfannenstiel, Dieter. General Accessibility Guidelines — Guidelines for Accessibility and Inclusive Design in Public Buildings in Pakistan. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, project number 20.2265.5-005.00. Berlin, August 2025.
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- 4) Federal Emergency Management Agency. *FEMA 547 — Techniques for the Seismic Rehabilitation of Existing Buildings*. Washington, DC: FEMA, 2006.
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