



Code of Practice for the Installation of Remedial Wall-Ties & Lateral Restraint Ties

1. Introduction

This Code of Practice is issued by the PCA herein after referred to as 'the Association'. This Code of Practice deals with the treatment of wall tie failure in cavity and masonry walls of existing buildings and is based on current best practice. It recommends the procedures to be used for diagnosing wall tie failure – in general for metal ties, the most commonly used type – and lays down the standards of workmanship required for installing remedial wall ties and lateral restraints and for making good afterwards. The Code includes references to other causes of failure that can occur in buildings and stresses the importance of eliminating these as well as dampness.

It does not constitute or provide a work specification.

The systems described (Section 8) are processes approved by independent BBA certification. Other systems may also be used by specialist contractors in which case most sections of this Code of Practice will still be applicable. However, users/specifiers of non BBA certified systems should seek verification that the materials/processes are able to provide adequate control over periods of time.

In all cases the requirements of the Building Regulations and/or any local building bylaws must be observed and where necessary the advice of the Local Authority Building Inspector should be taken.

2. Definitions

For the purpose of this document, the definitions in BS 6100:Part 5 [6] applies with the following amendments/additions:

Precautionary Notices

Notices providing warnings about hazards associated with the use of materials and any associated chemicals and precautions to be observed by other trades, clients and the public.

3. Health and Safety

3.1 General Measures

3.1.1 The Health and Safety at work etc. 1974 (and its subsequent amendments)

Requires every employer to be responsible, in so far as reasonably practicable, for the provision of a safe working environment, the provision of appropriate safety equipment and instruction, training and information on the Safe Use of Plant, Equipment and Materials necessary for the job.

Employees in turn have an obligation to make proper use of the safety equipment provided and to act upon the information and training given to ensure their own safety and that of others who may be affected by their acts or omissions [20].

Particular note should be made of recent Regulations passed under this Act, which may be relevant to remedial wall tie works [21,22,23,24].

3.1.2 Precautionary Notices

These should be conspicuously displayed during treatment and if appropriate, for a period of time following completion.

3.1.3 Guidance on Safe Practice & Storage

Specific advice for individual products is available in Manufacturers' Product Data Sheets. Variable site locations should be taken into account when making risk assessments (see [25,26]).

3.2 Fire-Precautions

3.2.1 When flammable products are being used (e.g. Resins), appropriate measures should be taken at all times to reduce fire risks to a minimum. Such measures should include adequate ventilation and the provision of fire extinguishers of a suitable size and type, which must be available to and within easy and safe access of the operators. All such appliances should be maintained in accordance with the manufacturer's instructions and as laid down in BS5306. [5].

3.2.2 All electrical equipment should comply with the current edition of the Institute of Electrical Engineers (IEE) Regulations. Items should be properly maintained at all times and handled with care to avoid damage.

3.2.3 Electrical circuits and installations must be properly and adequately safeguarded.

3.3 Obligations to other persons, the environment and other properties at risk

Where deemed appropriate (under clause 3.1.1 above) neighbours/owners of adjoining or nearby properties must be notified direct if it is considered there may be a hazard to their health from work being carried out. Information should include the type of hazard (e.g. flammability/dusk/noise), method of application (and any potential risks there from) and some recommendations on precautions to be taken before and during installation.

4. Training

- 4.1** All staff must have received training commensurate with their duties. Training in the safe and effective installation of wall-ties/lateral restraint systems should be in compliance with the requirements of BRE Digest 401: 'Replacing Wall Ties' [12].
- 4.2** For surveyors, standards of training and competence must be achieved by completing a training course approved by PCA. When a survey for wall-tie or lateral restraint work reveals dampness which may affect timbers or the surveyor suspects rot or insect attack then unless the surveyor is competent to diagnose and specify remedies for such problems a supplementary inspection should be carried out by a suitably qualified surveyor (e.g. a surveyor holding the Certificated Surveyor in Remedial Treatment (CSRT) qualification).
- 4.3** For technicians, standards of training and competence are achieved by obtaining a Level 2 National Vocational Qualification (NVQ) for Wall-tie replacement. This is incorporated within the occupational standards for Remedial Maintenance Operations set by Construction Industry Training Board (CITB)/City & Guilds.
- 4.4** The Construction Skills Certification Scheme (CSCS) enables every competent technician, who may not have an NVQ, to be registered with a CSCS card. The CSCS card also provides, evidence that the technician holds a valid CSCS Health and Safety Awareness Training Certification.

NOTE: General advice on training is available from the Association.

5. Standards and Codes

5.1 Products

Remedial wall tie materials or systems may hold a current British Board of Agrément Certificate see (8.4 Appendix A) or may be approved by an accredited independent body.

Remedial Ties

All Remedial ties shall be obtained from suppliers registered to ISO 9000.

A range of ties is available and the choice of a suitable tie from this range will be the responsibility of the installer in accordance with the guidance given in BRE Digest 329, 1993, Installing Wall Ties in Existing Construction [10]

Pull out tests shall be carried out on site to prove the suitability of the tie system adopted. Remedial wall ties shall be tested in compliance with the specification of BRE Digest 401: 1995 – Replacing wall Ties (Tables 5, 6 & 7) [12].

5.2 Advisory Documents

The following are directly relevant to remedial wall ties and lateral restraints:

BRE Digest 329: 1993:
Installing Wall Ties in existing construction. [10]

BRE Digest 401: 1995
Replacing Wall Ties (Tables 5, 6 & 7) [12]

DD 140: Wall ties:
Part 1: 1986 Methods of test for mortar joint and timber frame connections [9]
Part 2: 1987 Recommendations for design of wall ties [9]

Details of these and some other useful documents concerned with remedial wall ties and lateral restraints are listed in Section 12.

6. INSPECTIONS

6.1 General Considerations

- 6.1.1 Inspections should not normally exceed the instructions received from the client. However, a note should be made of any other relevant problems that are observed and these should be reported in writing.
- 6.1.2 Only staff who have been adequately trained in the identification of wall tie failure/lateral movement in buildings must undertake inspections. They must be competent to specify appropriate remedial measures. Such staff must have a good working knowledge of all traditional styles of building construction.
- 6.1.3 Particular emphasis is to be placed on the role of dampness in initiating and influencing metal wall tie and render problems. Staff should include consideration of these matters when specifying an installation and formulating the remainder of the remedial specifications.
- 6.1.4 The Surveyor should be adequately equipped. This will normally include metal detector, endoscopes, battery operated power drill and repair materials, floorboards lifting tools torch, mirror, portable ladder and notebook. Additional surveying aids may be required in accordance with the company's practice and of any special features of individual surveys.
- 6.1.5 Fitted carpets, skirting boards, etc. and furniture should not be disturbed or removed without the permission of the owner and/or his agent.
- 6.1.6 The Surveyor must have and use the personal protective equipment identified by any risk assessments carried out under the Management of Health and Safety at Work Regulations 1992 [21] and/or the current Control of Substances Hazardous to Health (COSHH) Regulations [23].
- 6.1.7 Adequate site notes (including plans and/or photographs) are of prime importance and in addition to the survey findings the following should be recorded and retained:
 - a) The type (e.g. domestic, industrial) and style of construction and history of the building.
 - b) The scope of the survey.
 - c) The likelihood of concealed or built-in-timbers.
 - d) The extent of any structural deterioration and the repairs required (as assessed at the time of inspection).
 - e) The presence and type of any built-in or retrofitted cavity wall insulation. If present, the client should be advised to ascertain the effect of remedial work on any guarantee related to the insulation.

NOTE: If the structure being inspected is considered to be dangerously unstable immediate action must be taken to notify the owners or their agents and to ensure public safety [25].

6.2 Structural Considerations

The Surveyor must determine if the problem can be resolved using remedial wall ties or lateral restraint ties, or whether additional work is required. Many types of work are amenable to being repaired by ties alone, but difficulty will be experienced in the following examples:

- Masonry walls in excess of 325mm.
- Rubble filled walls.
- Insulation filled, fully or partially, cavity walls.
- Walls constructed from local materials e.g. Clay lump cob.
- Stud walls
- Masonry walls spanning a stairwell or hollow areas.
- Masonry in-fill panels with concrete with concrete structures.

Note: The involvement of a Structural Engineer in the approval of any lateral restraint specification is strongly recommended or where bowing resulting from excessive or eccentric loads are suspected.

6.3 Inspection Procedure, Survey & Diagnosis

6.3.1 Inspection Procedures

A visual inspection must be carried out to determine which areas of the structure are affected by bulging and bowing and cracking (but see 6.2). Deformed masonry which shows signs of regular horizontal cracking is likely to be suffering from wall tie failure generally and the entire structure may need to be treated.

Where bulging has been detected as floor level the directional run of the floor joists must be checked to determine if the joists are parallel to or at right angles to the wall.

Where joists are at right angles to the wall, particularly in older solid masonry, the ends of the joists must be checked for decay and the amount of embedment in the inside face. The joists may need repair and treatment as a separate procedure.

Note must be made of the nature of the wall e.g. solid brickwork or cavity masonry and the overall thickness determined including a measurement of the width of any cavity present.

Joist centres need to be checked and this can be done quite easily when there is internal access to the property by checking nailing centres in wooden floors. Alternatively, end-on joist centre may be determined using an endoscope and the position and dimensions of parallel joists by careful drilling from outside.

Where the bow is considered excessive visually or is becoming structurally unsound the area of masonry affected will need to be taken down and rebuilt.

6.3.2 Survey and Diagnosis

Where wall tie problems are suspected the wall should first be scanned with a metal detector to determine the density of the existing ties.

The condition and type of tie must be evaluated. This can be done initially by using an endoscope near to an existing tie unless cavity fill insulation prevents it. To assess the tie condition fully, the brick above the tie should be removed to allow a full inspection of the ties embedded end for corrosion.

Ties should be inspected in each wall and preferably at different heights.

If brick removal is not feasible then an endoscope inspection alone may have to suffice. Careful drilling/chiseling around the tie may allow the tie end to be exposed and its condition checked.

Care must be taken to reduce the risk of debris causing cavity bridging especially in insulated cavities.

Once it has been determined that there are failed or unacceptably corroded ties in the structure, the problem of continuing corrosion must be addressed.

Heavy-duty, mild steel ties corrode, expand and cause horizontal cracking in the masonry. These must be treated, preferably by cropping, removal or isolation from the structure to prevent further damage.

Corrosion can cause mild steel to expand up to several times its original

thickness. One of the classic symptoms of wall tie corrosion will not be sufficient to cause cracking. However, in thin joints with hard mortar, treatment will usually be required.

6.4 Access

Proper access for inspection should include access to all parts of the building both internally and externally but may not necessarily include the ability to examine existing wall ties physically due to the unacceptability of disturbance to existing finishes.

7. Reports

7.1 General Following the inspection, a report should be submitted to the client confirming the instructions received areas to which access could not be gained and describing the surveyor's observations and recommendations [26]. If appropriate, any quotation submitted for ambiguity and bears a direct relationship to the work detailed in the report. All necessary preparatory and other associated works (e.g. accessibility, external finishing) should be detailed including clear instructions defining who is responsible for such works. In the case of works adjacent to/and or affecting party walls, clients should be advised that permission from adjoining property owners might be required, Under the Party Wall Act 1996, prior to works commencing.

7.2 Associated Works The overall success of wall-tie and lateral restraint remedial works may depend ultimately on a number of factors that are often the responsibility of others (e.g. pointing, rendering, plastering, cavity clearing etc.). In as far as is practical, the report should identify these areas and give recommendations concerning appropriate specifications.

Specification

A specification shall clearly state for the benefit of all parties, precisely what treatment if any, is to be applied to each elevation.

Different forms of treatment may be specified for different parts of a subject property; however, areas requiring different forms of treatment shall be clearly defined e.g. 'Front elevation upper storey: demolish and rebuild the outer leaf. Front elevation lower storey: locate, remove and renew existing ties'.

A specification shall be completed for each property inspected.

7.3 Structural Timbers In all cases where the presence of moisture is identified the condition of associated structural and other timbers should be ascertained where possible. If circumstances preclude a detailed inspection it should be noted in the report that timbers in such areas may be at risk from fungal decay/insect attack and further inspection recommended. This is particularly relevant in the case of suspended timber floors in contact with walls in which dampness is found or suspected (see Section 8.2.4).

8. Products and Installation Measures

8.1 Selecting a suitable system

Treatment

Treatment of the subject property may include installation of remedial wall ties, removal of existing ties, lateral restraint of elevations, rebuilding of brickwork and repairs to external finish. A job record sheet shall be maintained by the operatives on a daily basis for retention by the installer.

8.1.1 Wall Ties

Both solid masonry and cavity masonry may need to be tied if there are signs of separation of the layers of masonry in the structure.

Solid masonry commonly becomes delaminated due to header bricks cracking, or mortar deteriorating – particularly lime mortars.

Cavity masonry frequently fails due to wall tie corrosion or omission as most old structures do not incorporate stainless steel ties but use galvanized or painted ties when originally built.

The function of the wall ties in cavity masonry is often not well understood. They are there to provide support from the inner, loading-bearing wall, to the outer façade to resist the effects of wind suction and compression. The ties must be made to prevent water transfer across the cavity and to be sufficiently flexible to allow differential movement between the two walls without unduly stressing the connection in the mortar.

It is generally agreed, that wherever possible, ties used in new construction should now be made from austenitic stainless steel. In older structures the ties were made from slate or tile, which prove to be brittle, cast iron which also tends to be brittle, mild steel coated in bitumen or zinc which may be heavy section fish-tail ties or light wire ties both of which corrode. The heavier sections expand and damage the masonry while the lighter wire ties break without causing external damage.

Remedial ties should be selected to ensure that no further problems are created and corrosion resistant austenitic stainless steel is generally preferred. Some ties may incorporate components made from bronze, brass, neoprene or nylon.

It is important that the ties are able to meet the loads anticipated and provide the facility to accommodate the on-going movement of the structure.

Ties must be selected which are suited to the substrate into which they are to be fixed! This may seem obvious but it is not uncommon to find the unwary trying to use a resin bond into aircrete (AAC) or into the inner face of the cavity wall, where the cavity is filled with loose insulating fibre or styrene material.

The golden rule for repair work is to use a few more ties rather than rely on a few high strength connections. This will overcome any of the weaknesses in the masonry, which, have developed over time.

Always insert the repair ties before treating the old ties or removing any masonry.

Where treatment in 'soft' or friable substrates is to be carried out the use of expanding mechanical-to-mechanical systems is generally not recommended.

8.1.2 Lateral Restraint Lateral restraint ties are only suitable where they can be bonded into the outer masonry, either mechanically or chemically, with the inner end fixed into something solid. They are not suitable in masonry walls adjoining stairwells, passageways and any other area where it is not possible to achieve an internal anchorage.

There are many methods and products available and the advice given for the most appropriate will vary according to the cause of the problem, the detail of the construction and whether it is possible to have access to the interior of the property, including lifting the floorboards.

Generally speaking, the lateral load to be restrained is not high. As a rule of thumb, to restrain a bulge resulting from weathering for example, the horizontal force needed is only about 2.5% of the vertical load.

Restraint ties are only required to resist outward movement of the wall and not to provide compressive resistance or shear load support to the floor structure.

Restraint ties should be spaced at a maximum of 2m apart. There is a widely held school of thought which suggests that more closely spaced, lightly loaded restraint are better suited to meeting the demands of the masonry, regardless of the strength of the tie bond.

8.1.3 Suitability If there is any doubt about the suitability of a particular system, the manufacturer of that system should be contacted for advice and site tests carried out where necessary.

Common cavity fill insulation materials (e.g. urea formaldehyde foam, mineral wool etc.) may interact adversely with some wall tie systems. Walls with cavities containing polystyrene should be treated with care when using solvent based adhesives (resins) although expanded polystyrene may be installed in a treated cavity wall after the solvent has evaporated. It should be noted that solvent-based products might also cause damage to polyethylene and bitumen membranes, and some flooring materials and adhesives.

8.1.4 Recommended Further Reading BRE Digests: 329 & 401 [10&12]

BRE Good Building Guides:

- GBG 28 Part 3 [14]
- GBG 29 Part 1 – A practical guide to connecting walls and floors [15]
- GBG 29 Part 2 – Design and Performance [16]

BS 5628: 1990

Code of Practice for Brickwork Parts 1 & 3 [4]

BS 8103 Part 2:

Code of Practice for Masonry Walls or Housing [8]

8.2 Pre-Installation Measures

8.2.1 The installer should confirm that the owner and/or occupier of any adjoining property have been advised before starting any installation that may directly affect them.

8.2.2 Precautionary Warning Notices should be posted prominently at the treatment area.

8.2.3 Disconnect electrical fittings from the supply and note the locations of any pipe work (water and gas). The presence of hidden services within the cavity and ceilings voids should be anticipated.

8.2.4 Where suspended timber floors exist, inspect joist ends and other timbers in contact with damp walls e.g. wall plates, sleeper walls, to ensure that they are free from fungal decay. If such problems are located, inform the client and, if instructed, implement the necessary repairs ensuring that any sound retained or replacement timbers are isolated from the masonry and give consideration to the need for preservative treatments [19].

Care must be taken when isolating joists from walls to maintain support so that movement does not occur. The work is to be carried out in a planned and controlled manner.

8.2.5 Even where there is no visible evidence of fungal decay on the exposed faces of the timbers, the concealed sections should be regarded as being at greater risk. Isolation of such timbers from masonry is therefore highly recommended (suitable methods may include completely rebuilding the floor in line with the guidance in [11]).

NOTE 1: It is strongly recommended that specialists contractors undertake all

timber/ damp treatment work.

- 8.2.6 Where necessary, re-pointing and repairs to any defective masonry should be carried out with a weak 9e.g. 1:6) cement: sand mix.
- 8.2.7 If resin systems are used check that other chemical treatments being applied in the area (e.g. against dry rot and rising damp) will not affect them.

Location of Replacement Ties

Replacement ties shall not be located closer than 200mm to any existing ties unless this can be shown to be unavoidable.

Identification and location of existing ties shall be carried out prior to installation of replacement ties and their position marked on the outer leaf surface. The position of the new replacement ties may therefore be marked out to meet the requirements stated in (8.3) of this Code of Practice (and as directed by the Architect/Engineer if relevant).

Treatment of Existing Ties

Where the existing ties are found to be of sufficient thickness to cause a potential problem due to rust expansion, they should be completely removed, cropped off at their interface with the internal wall or isolated.

8.3 Installation Methods

8.3.1 General In all cases the installation of remedial wall-ties and lateral restraints can involve:

- Installation of remedial wall ties
- Removal of existing wall ties
- Lateral restraint of elevations
- Rebuilding of brickwork and repairs to external finishes

8.3.2 Contract Testing Prior to commencement of the work, trials shall be conducted on site by the appointed contractor using the specified ties and the plant and equipment intended to be used for the work to establish working procedures and test the pull-out resistance of the ties.

A number of ties will be installed for each base material condition or elevation combination known to exist.

The results of ties shall be recorded.

8.3.3 Length of ties Cavity brick walls frequently exhibit variable cavity width even within a length of wall. The contractor shall carry out a survey on the walls, by drilling, if necessary, in order to determine the various lengths of ties necessary.

8.3.4 The contractor shall follow the recommendations of the chosen wall tie manufacturer in all aspects of correct tie installation.

8.3.5 Drilling Operations The use of a rotary percussion or light SDS type drill is recommended for the drilling of holes. Each drilling machine should be fitted with a depth stop gauge to prevent over-drilling.

All holes drilled through the brickwork must be horizontal or inclined slightly downward towards the outside. On no account must any tie be installed in which the angle inclines toward the inner leaf.

8.4 PRODUCT QUALITY All products should be covered by Agreement certificates or approved by reputable independent bodies. Other products and systems may be used by specialist installers in which case most sections of this Code of Practice will still apply. However, users/specifiers of such products should ensure that the

alternative products would be able to provide adequate performance over a period of time, generally not less than 25 years.

9. FINISHING WORK

- 9.1 In general external holes in the brickwork, render or mortar joints should be made good with cement/sand mortar or mastic (coloured to match) or use original brick drillings.
- 9.2 Remove any scaffold used and leave the site in a clean and tidy condition.
- 9.3 Replace and make good any disturbed internal timbers.
- 9.4 Rebuilding of brickwork. The rebuilding of brickwork shall be carried out in accordance with BS 5628[4].
- 9.5 Insulation. Reinstatement of any disturbed insulation shall be carried out in accordance with client's instructions.

10. Complaints Procedure

- 10.1 All complaints/requests for re-inspection should be acknowledged in writing.
- 10.2 The surveyor carrying out the investigation should have available copies of all the information relevant to the job, i.e. the survey report and estimate and details of the actual work carried out, and should be familiar with this information before visiting the site.
- 10.3 The surveyor should first establish that the locations concerned formed part of the work contracted for and, as far as it is practicable to do so, check that work has been carried out in accordance with the work schedule and with this Code of Practice.
- 10.4 Check that any recommendation for ancillary work to be carried out by others has in fact been done, with reference to the original survey report.
- 10.5 If the above points are in order it is advisable to look for evidence of other sources of moisture ingress. Signs of disrepair should be checked against the original survey report, together with any evidence of new building work or repairs that might have affected the treatment.

- 11. **Quality Control** Routine testing of ties will be carried out in accordance with the guidance given in BRE Digest 401 [12] to ensure the ties meet the performance requirements laid down in BS DD 140 Part 2 [9] or as directed by the Architect/Engineer.

12. References **British Standards**

- | | | | |
|---|------------|------|------------------------------------------------------------------|
| 1 | BS5080 | 1974 | Part 1 Code of Practice |
| 2 | BS5262 | 1991 | Code of Practice for External Rendering |
| 3 | BS5268 Pt5 | 1989 | Code of Practice for Preservative Treatment of Structural Timber |
| 4 | BS5628 | | |

BRE Building Research Establishment

- | | | |
|----|-----------------------|-----------------------------------------------|
| 10 | Digest 329 | Installing wall-ties in existing construction |
| 11 | Digest 364 | Design of timber floors to prevent decay |
| 12 | Digest 401 | Replacing wall-ties |
| 13 | CIRIA Report 117-1988 | Replacement ties in cavity walls |

BRE Good Building Guides

- 14 GBG 28 Part 3 Domestic floors: assessing them for replacement or repair
- 15 GBG 29 Part 1 A Practical guide to connecting walls & floors
- 16 GBG 29 Part 2 Design and performance

PCA
Property Care Association

- 17 Code of Practice for Remedial Timber Treatments

HSE
Health and Safety Executive

- 18 A Guide to the Health and Safety at Work Act
- 19 Management of Health & Safety at Work Regulations
- 20 Provision & Use of Work Equipment Regulations
- 21 Manual Handling Operations Regulations
- 22 Construction (Design & Management) Regulations
- 23 COSHH and Peripatetic Workers
- 24 Evaluation and Inspection of Buildings and Structures

The information contained in this leaflet is given in good faith and believed to be correct. However, it must be stressed that of necessity it is of a general nature.

The precise condition may alter in each individual case and the Association is therefore unable to accept responsibility for any loss howsoever arising from the use of the information contained therein.

Property Care Association
11 Ramsay Court
Kingfisher Way
Hinchingsbrooke Business Park
Huntingdon
Cams
PE29 6FY
Tel: 08443 754 301
Fax: 01480 417587
Email: pca@propety-care.org
Web: www.property-care.org

The Property Care Association incorporating BWPDA is a company limited by Guarantee: Registered No. 5596488 England