DISTRESS PHENOMENA OFTEN MISTAKENLY ATTRIBUTED TO FOUNDATION MOVEMENT

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PREFACE

This document was first peer reviewed and published as Revision 0 on 1 December 2000. After obtaining additional feedback, it has been updated by the Structural Committee to Revision 1 and again been peer reviewed by the Foundation Performance Association (FPA).

This document is based on experience gathered by engineers in Houston, working primarily in the southeast Texas area. It is intended to be used in southeast Texas by homeowners, building owners, builders, foundation repair contractors, inspectors, engineers, architects, and others involved with structural inspection, forensic assessment, and/or monitoring of residential and other low-rise buildings. Information contained herein is provided as a guide only, and caution should be exercised when applying the information to other types of buildings or outside the geographic area for which it was intended.

This document is made freely available to the public through the Foundation Performance Association at www.foundationperformance.org so that engineers, inspectors, owners, builders, realtors, and other interested parties may have access to the information. To ensure this document remains as current as possible, it has been and will continue to be periodically updated under the same document number but with new revision numbers such as 2, 3, etc. If sufficient comments are received to warrant a revision, the Structural Committee will form a new subcommittee to revise and reissue this document in accordance with the FPA Technical Paper Peer Review Procedure. If the revised document successfully passes FPA peer review, it will be published on the FPA website and the previous revision will be deleted.

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INTRODUCTION

Architectural and structural distress in residential and other low-rise buildings in areas of Texas having expansive soils is a common occurrence and may be the result of differential foundation movement. However, not all observed distress results from foundation movement. The purpose of this document is to provide the user with a tabulation of phenomena that may occur in buildings or their foundations that are sometimes incorrectly attributed to foundation movement. For each distress or otherwise negative phenomenon, an attempt was made to provide a more probable cause of the phenomenon. Possible reasons or events that may have led to the direct cause of distress are also provided along with repair recommendations.

NEGATIVE PHENOMENON	PROBABLE CAUSE OF PHENOMENON	POSSIBLE REASON FOR CAUSE	REPAIR RECOMMENDATION
1. Masonry cracks above long lintels (e.g., garage door).			
a. Cracks at midspan.	a. Lintel beam undersized or overloaded.	a. Gravity load is causing lintel to deflect excessively.	a. Reinforce or replace lintel, and patch cracks or replace brick.
b. Cracks at ends.	b. Insufficient bearing surface.	b. Excessive lintel deflection or masonry is crushing.	b. Reinforce or replace lintel, and patch cracks or replace brick.
c. Grout cracks at first brick of soldier course on either side.	c. Insufficient bond of mortar to brick.	c. Thermal stresses can cause initial bond to break.	c. Patch crack with non-shrink mortar or fine grout.
2. Vertical cracks in masonry running full height of wall with uniform crack width from top to bottom of wall and usually located near center of wall or openings.	Thermal contraction and expansion of masonry wall.	Insufficient number, spacing, or width of expansion joints provided when masonry was constructed, or expansion joints were made ineffective during construction by excessive mortar obstructing joints.	Saw cut vertical expansion joints into brick as required, and repair existing ineffective expansion joints.
3. Surface cracks in post-tensioned slabs prior to tendon stressing (typically perpendicular to long dimension).	Concrete shrinkage during curing process.	As water naturally evaporates out of slab, voids are left causing shrinkage cracks.	Cracks typically close after stressing. No repair is usually required.
4. Cracks, or buckling, at top of walls supporting sloping roofs.	Inadequate horizontal restraint at top of walls, causing walls to bow outward and drywall to separate as ridge settles and sloping roof members push wall laterally.	Inadequate design or construction, missing collar ties, or overloading of roof or attic.	Add collar ties or reinforce ridge and eliminate any overloading.
5. Spalled concrete at corner of foundations supporting brick walls.	Brick bonds to grade beam when wall thermally expands and contracts.	Lack of bond breaker between brick and brick ledge.	Spalled area can be cosmetically patched with a bonding agent and non-shrink grout.
6. Cracks along gambrel and other vaulted ceilings, usually on exterior walls.	Ceiling joists are supported by rafters, and rafters expand and contract more than ceiling joists due to temperature changes.	Ceiling joists and rafters may not be adequately nailed together or supported.	Provide flexible material, such as caulking, at drywall intersections of sloping roof and ceiling.
7. Sags and cracks in drywall ceiling.	a. Excessive deflection of beams and stud wall plates, causing drywall to crack.	a. Undersized wood beams, improper support of wood beams, or overloaded attic roof members.	a. Analyze wood support beams and reinforce as required. Investigate whether there is adequate support for beams.
	b. Inadequate nailing.	b. Improper construction or loss of nails due to popouts resulting from wood shrinkage.	b. Add nails.
8. Cracks and spalls in first story brick, when second story is wood-framed and second story exterior walls are not clad with brick.	Excessive gravity loads on brick resulting from inadequate support of second story.	Improper engineering, construction or overloading; second story may be supported by brick that may not have been designed to be load-bearing.	Adequately support second story walls, and eliminate any overloading.

NEGATIVE PHENOMENON	PROBABLE CAUSE OF PHENOMENON	POSSIBLE REASON FOR CAUSE	REPAIR RECOMMENDATION
9. Ground floors are noticeably out of level, but there is no apparent evidence of distress.	Slab may have been originally constructed out of level.	Formwork not level during construction.	Begin slab elevation monitoring program on a quarterly basis to confirm there is no abnormal movement.
10. Nails popping out of walls and ceilings in structures.	a. Shrinkage of wood members.	a. Wood members may have become wet during construction.	a. Wait approximately two years for wood shrinkage to subside, and then repair.
	b. Infiltration of moisture into wall or ceiling.	b. There may be a roof, wall, or plumbing leak.	b. Repair leaks.
	c. Structural framing movement.	c. Flexure due to wind.	c. Consult structural engineer.
11. Crown molding separation in newly constructed structures.	Shrinkage of wood members or caulking.	Wood members may have become wet during construction, and shrunk while drying.	Wait approximately two years for shrinkage to subside, and then repair.
12. Drywall separation around tape seals and corner beads in newly constructed residences.	a. Shrinkage of wood members.	a. Wood members may have became wet during construction, and shrunk while drying.	a. Wait approximately two years for shrinkage to subside, and then repair.
	b. Insufficient bonding of corner beads at joints.	b. Insufficient nailing of corner beads.	b. Add more nails or screws, and then refloat.
13. Miscellaneous cracking in concrete foundation with no apparent distress in superstructure.	a. Concrete may have impurities in cement matrix.	a. Deleterious chemical reactions may cause cracking of concrete.	a. Wait until cracking appears dormant, and then repair as needed.
	b. Concrete shrinkage during curing process.	b. As water naturally evaporates out of slab, voids are left causing shrinkage cracks.	b. Wait until cracking appears dormant, and then repair as needed.
	c. Surface shrinkage cracks due to excess water during foundation construction.	c. Over vibration during foundation construction with excessive bleeding of concrete.	c. Wait until cracking appears dormant, and then repair as needed.
	d. Crack around reinforcement.	d. Moisture penetrated concrete and caused rebar corrosive expansion, resulting in concrete spalling.	d. Wait until cracking appears dormant, and then repair as needed.
14. Short horizontal brick cracks at window lintels.	Lintel corrosion expanding and lifting brick.	Inadequate lintel corrosion protection.	Remove rust, clean, paint, and seal exposed lintel ends.
15. Doors that bind at bottom, but are easy to open or close if lifted by knob.	a. Door hinge is loose.	a. Screws are too small or too short for weight of door.	a. Tighten or replace hinge with longer screws.
	b. Door hinge is too small.	b. Hinge is too weak or not enough hinges.	b. Replace or add additional hinges.
	c. Door has sagged or racked.	c. Glue that binds door components together has deteriorated.	c. Replace door.
16. Masonry cracks adjacent to garage door jamb 1-ft to 2-ft above slab, frequently with outward displacement of brick at crack, and frequently with misaligned garage door jamb.	Veneer or jamb damaged by horizontal impact load.	Veneer or jamb hit by passing auto bumper.	Repair brickwork and wooden jamb.

NEGATIVE PHENOMENON	PROBABLE CAUSE OF PHENOMENON	POSSIBLE REASON FOR CAUSE	REPAIR RECOMMENDATION
17. Cracks in individual floor tiles, but cracks do not connect to other cracks in adjacent tiles and there are no mortar cracks.	Cracks are inherent in tile material.	Cracks passed inspection during tile manufacturing process or tile was damaged by installation or fallen object.	Replace tile if not cosmetically acceptable.
18. Continuous cracks in grout lines and/or hard surface floor tiles in newly constructed residences.	a. Concrete continued to shrink during curing process after floor tiles were installed, leaving small cosmetic hairline cracks.	a. Cracks due to continued concrete shrinkage cause reflective cracking in tiles that are bonded to concrete floors.	a. Wait until cracking appears dormant, and then replace tiles (typically 1 to 2 yrs). When replacing tiles, provide an elastomeric membrane between tiles and concrete that prevents bonding.
	b. Internal overstress in tile resulting from inadequate gap between edge of tile and wall, cabinets, bathtubs, or other fixtures that are installed before tile is set.	b. Expansion of tile or shrinkage of concrete substrate may lead to compressive stress buildup in tile if edges of tile are restrained from horizontal movement. Inadequate clearance may be due to improper design or construction.	b. Remove grout adjacent to walls and fill with caulk.
19. Doors that open or close on their own (ghost doors).	Door is not plumb.	Poor installation.	Slightly bend hinge pin, or add shims to realign.
20. Doors do not latch.	Keeper is out of alignment.	Poor installation.	Move keeper.
21. Dips or humps in floor system at second floor.	Floor system was not constructed level.	Floor system was constructed out of level or has deflected excessively due to overloading.	Consult structural engineer, and eliminate any overloading.
22. Buckled trim boards around window sills and other areas where moisture can occur.	Trim boards became wet and swelled.	Materials used are simulated wood products sensitive to moisture changes.	Repair or replace with wood or other product less sensitive to swelling.
23. Wrinkling in vinyl floor sheathing.	Inadequate bonding.	Inadequate adhesive, floor preparation, and/or water migration.	Remove and replace vinyl flooring and eliminate any moisture migration.
24. Loose carpet seams.	Inadequate carpet installation.	Adhesive not sticking, carpet cross-laid, and/or bad edge cutting.	Repair carpet.
25. Wrinkled carpet.	a. Carpet became wet.	a. Carpet stretched when wet.	a. Dry and re-stretch carpet.
	b. Carpet is loose.	b. Carpet is not adequately attached to tack strips.	b. Re-stretch and secure carpet.
26. Buckles in wood floor planks.	Wood planks became wet and swelled.	Wood products are sensitive to moisture changes.	Eliminate moisture migration.
27. Cracking and buckling of drywall around HVAC vents.	Local overstress due to thermal expansion and contraction.	Difference in expansion and contraction characteristics of drywall and metal.	Allow for thermal expansion between HVAC vent and drywall.