STRUCTURAL EVALUATION OF

NORTH CAMPUS/TLC/VISTA CONTINUATION HIGH SCHOOL

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT (WCCUSD)

For

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Kaiser Building
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By

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10.1 Introduction

The purpose of this report is to perform a seismic assessment of the North Campus/TLC/Vista Continuation High School in San Pablo, CA. The structural assessment includes a site walk through. The purpose of the structural assessment is to identify decay or weakening of existing structural materials (when visible), to identify seismic deficiencies based on our experience with school buildings, and to identify eminent structural life-safety hazards.

The school campus has had a walk-through site evaluation and a limited study of available architectural and structural drawings. The general structural condition of the buildings and any seismic deficiencies that are apparent during our site visit and review of existing drawings are documented in this report. This report includes a qualitative and quantitative evaluation of the buildings. A limited lateral (seismic) numerical analysis was performed to identify deficient lateral elements that could pose life safety hazards.

The site visits did not include any removal of finishes. Therefore, identification of structural conditions hidden by architectural finishes or existing grade was not performed.

10.2 Description of School

The school was built in 1963. The original building is a one-story wood-framed structure (main building). A one-story multi-purpose building and connecting corridor were in 1965. There are two main buildings (permanent structures) and thirteen portable buildings (see figure 1). The construction dates of the portables are not known, but appear to have been built after 1985. The total square footage of the permanent structures is 42,052 square feet.

10.3 Site Seismicity

The site is a soil classification S_C in accordance with the 2001 California Building Code (CBC) and as per the consultants, Jensen Van Lieden Associates, Inc.

The main classroom building has an educational occupancy (Group E, Division 1 and 2 buildings) and the multi-purpose building has an assembly occupancy (Group A, Division 3), both of which have an importance factor in the 2001 CBC of 1.15. The campus is located at a distance of 2.9 kilometers from the Hayward fault. The main and multi-purpose buildings are wood framed buildings with plywood shear walls, and have a response modification factor R = 5.5. The 2001 CBC utilizes a code level earthquake, which approximates an earthquake with a 10% chance of exceedance in a 50-year period or an earthquake having a 475-year recurrence period.

The seismic design coefficient in the 2001 CBC is:

$$V = \frac{2.5CaIW}{R} = \frac{2.5(0.40x1.41x1.15)W}{5.5} = 0.295W$$

The site seismicity is used to provide a benchmark basis for the visual identification of deficient elements in the lateral force resisting systems of campus buildings. The calculated base shear was used to perform a limited lateral analysis of the school buildings as described in section 10.7.

10.4 List of Documents

1. Kerry Hills School; Jack Buchter, Architect and Eric O. Moorehead, Structural Engineer; sheets 1-6, S1-S5, P1, MP1, M1, E1-E2; February 1, 1963; DSA #23621.
2. Addition to Kerry Hills School; Jack Buchter, Architect and Eric O. Moorehead, Structural Engineer; sheets 1-3; S1-S5, M1, P1, E1; June 22, 1965; DSA #26221.
3. "Measure D" - WCCUSD Middle and High Schools– UBC revised parameters by Jensen- Van Lienden Associates, Inc., Berkeley, California.

10.5 Site Visit

DASSE visited the site on August 15th, 2002. The main purpose of the site visit was to evaluate the physical condition of the structure and in particular focus on the lateral force resisting elements of the building. Following items were evaluated during the site visit:

1. Type and Material of Construction
2. Type of Sheathing at Roof, Floor, and Walls
3. Type of Finishes
4. Type of Roof
5. Covered Walkways
6. Presence of Clerestory Windows
7. Presence of Window Walls or High Windows in exterior and interior walls
8. Visible cracks in superstructure, slab on grade and foundation

The main building is a one-story wood-framed structure with a plaster exterior finish and a large number of windows, particularly in the longitudinal walls (see figures 2 and 6 through 9). The building is shaped like an “8”, having two interior courtyards (see figure 1). Interior corridors are located along the courtyards in the longitudinal direction. The corridors and adjacent classrooms have windows that look into the courtyards, but there appear to be long segments of shear walls on the interior sides of the corridors (see figure 10). The corridors have acoustical tile ceilings and skylights are placed in the areas that are not adjacent to the central courtyards. Classrooms and administration areas have suspended T-bar ceilings. The transverse walls at the classrooms have no openings in them. The main entrance has a canopy above it that is attached to the building along the rear edge and is lower than the main roof diaphragm (see figures 2 and 15).

The multi-purpose building is a wood-framed structure with a plaster exterior finish and a split-level roof (see figure 3 through 5). The multi-purpose building has two main areas: the cafeteria / auditorium and the kitchen. The cafeteria / auditorium area has some windows in the front longitudinal wall and has a high roof that spans about 45 ft between longitudinal walls (see figure 11). The kitchen area has a lower roof and has multiple window openings along the exterior longitudinal wall. The transverse walls of the multi-purpose building have only minor openings. The cafeteria / auditorium has an acoustical tile ceiling and the kitchen area has a plaster ceiling. There is also a connecting corridor between the main and multi-purpose buildings that is attached to the multi-purpose building at the roof diaphragm level (see figure 3).

At the portable classrooms, there is electrical conduit running between the classroom units near the roof level (see figure 14). There are no flexible connections to allow for relative movement of the units. During an earthquake these conduits may be damaged and pose a threat to life safety.

10.6 Review of Existing Drawings

The main building is a large wood-framed structure, 275 ft long by 142 ft wide. The roof has a blocked roof diaphragm of ½" plywood sheathing over 2x18 joists spaced at 24" centers spanning 31 ft in the transverse direction. At the longitudinal corridors, 2x6 joists, spaced at 24" centers, are lapped and nailed to each other with 5-16d nails over supporting wood stud bearing walls. The walls are supported on 14" wide by 2'-6" deep strip footings. The ground floor is a 5" concrete slab-on-grade. The shear walls have 3/8" plywood sheathing nailed with 8d nails spaced at 6" centers. All of the transverse walls dividing the classrooms will act as shear walls but do not have holdowns to resist overturning forces. At the eastern end of the building, there are many window openings (see figure 6). In the longitudinal direction, the shear walls are located on the insides of the longitudinal corridors (see figures 7 and 19). Windows run along the length the corridor at the courtyard areas (see figure 10). At diaphragm openings, there are no collector elements in the transverse direction at the corners of the openings.

Because the transverse shear walls on the north and south halves of the building do not align with each other in plan, the roof diaphragm will act to transfer seismic shears laterally between the wall lines. The typical nailing of the roof joists to each other at supports will allow them to act as collector elements, transferring seismic forces across the diaphragm as required.

Since the exterior longitudinal walls do not have any shear panels (see figures 7 and 9), the roof diaphragm will cantilever horizontally outward from the corridor to the exterior of the building. The chord forces that could result from this cantilever action exceed the capacity of the 8-16d top plate splices.

At the north and south sides of the courtyards, the top plate collectors could be slightly overstressed by the anticipated collector forces. However, each shear panel along those wall lines is able to laterally support the area tributary to it. Therefore, the inadequacy of the top plate splice is not a significant threat to life safety.

Since the transverse walls run parallel to the roof joists and do not have holdowns at the ends, they will not have adequate overturning resistance during a strong earthquake event. The collector connections along the eastern end of the building are not adequate. As the building moves during an earthquake, the roof at the corners of the courtyard areas may be damaged due to a lack of reinforcement in the transverse direction.

The main building entrance canopy was not built in accordance with the original construction documents. The 3x4 canopy joists, spaced at 16” centers, are supported by three 7” x 9¾” glue-laminated beams. The existing drawings show the beams framing into the bearing walls on the sides of the entrance area. In the actual construction, however, the front and middle beams are supported by pipe columns at each end. At the rear edge of the canopy, the glue-laminated beam spans between posts in the bearing wall. Except at the rear edge, the canopy structure is not attached to the main building (see figure 15). A short plywood-sheathed shear wall is located above the rear beam to transfer seismic shears up to the roof diaphragm. There does not appear to be a complete lateral force resisting system since the canopy structure is only braced laterally at the back wall and the other three sides are not braced. This element could fall during strong seismic ground motions, posing a life safety hazard at the main entry.

The multi-purpose building has a tall assembly area and a shorter kitchen area. The building a blocked roof diaphragm of ½” plywood sheathing over 2x10 joists spaced at 16” centers. At the low roof, the joists span between bearing walls. At the connection of the low roof into the face of the taller bearing wall, the joists rest on a let-in 2x6 ledger and are lapped and nailed with 5-16d nails to the studs. At the high roof area, the joists span about 16’-8” between 7” x 26” glue-laminated beams which span 45 ft between the exterior longitudinal walls (see figures 11 and 12). Each glue-laminated beam is supported by 7” x 7½” glue-laminated columns on 3’-6” square spread footings. Except at the east wall, the stud walls of the high roof area have 2x8 studs spaced at 16” centers. The continuous spread footings beneath the exterior walls are 14” wide by 34” deep and the slab-on-grade is 4” thick.

Where the east and west ends of the low roof frame into the wall of the high roof area, there are re-entrant corners that cause stiffness discontinuities (see figures 4 and 5). Some minor damage to the walls may occur at these locations. However, it does not appear to be a significant threat to life safety because the positive connection of the low roof to the wall will prevent loss of gravity support for the low roof framing.

A short corridor connects the main building and the multi-purpose building. A seismic separation joint is located at the end adjacent to the main building (see figures 6 and 16). Windows are located along the entire north wall of the corridor (see figure 5). Light moment frames with steel 5I10 beams and columns are spaced every 10 feet along the length of the corridor and provide lateral support in the transverse direction. The beams are located in the space between the roof and the ceiling of the corridor. In the longitudinal direction, collector straps connect the walkway back into the roof framing of the multi-purpose room.

10.7 Basis of Evaluation

The document FEMA 310, Federal Emergency Management Agency, *“Handbook for the Seismic Evaluation of Buildings – A Prestandard,”* 1998, is the basis of our qualitative seismic evaluation methods to identify the structural element deficiencies. The seismic performance levels included in FEMA 310 allow the engineer the choice to achieve the Life Safety Performance or the Immediate Occupancy Performance. We have based our evaluation of school buildings on the Life Safety Performance level for which is defined as “the building performance that includes significant damage to both structural and nonstructural components during a design earthquake, though at least some margin against either partial or total collapse remains. Injuries may occur, but the level of risk for life-threatening injury and entrapment is low."

Because mitigation strategies for rehabilitating buildings found to be deficient are not included in FEMA 310 document, the California Building Code (CBC 2001) is used as the basis of our quantitative seismic evaluation methods and strategies for seismic strengthening of school buildings. The scope of our analyses were not to validate every member and detail, but to focus on those elements of the structures determined by FEMA 310 to be critical and which could pose life safety hazards. Element *strength* values not addressed in the California Building Code were based on the document FEMA 356, Federal Emergency Management Agency, *"A Prestandard and Commentary for the Seismic Rehabilitation of Buildings"* 2000.

10.8 List of Deficiencies

Building deficiencies listed below have corresponding recommendations identified and listed in Section 10.9, which follow the same order as the itemized list of deficiencies identified below. The severity of the deficiency is identified by a *"structural deficiency hazard priority"* system based on a scale between 1.0 and 3.9, which is described in Section 10.11. These priority ratings are listed in section 10.9. Priority ratings between 1.0 to 1.9 could be the causes for building collapses, partial building collapses, or life-safety hazards, if the corresponding buildings are subjected to major earthquake ground motions, which are possible at these sites. It is strongly recommended that these life safety hazards are mitigated by implementing the recommendations listed below.

Item	Building Structural Deficiencies
1.	At the main building, there are no shear walls at longitudinal exterior faces of building. This forces the roof diaphragm to act as a horizontal cantilever along those sides of the building. The top plate splices are overstressed due to chord forces.
2.	At the main building, there are large interior courtyards. There are no collector elements at the corners of these diaphragm openings in the transverse direction. This may result in damage to the diaphragm at the corners.
3.	At the east end of the main building, the collector connections are overstressed.
4.	The interior transverse shear walls have neither holdowns nor sufficient weight to resist the seismic overturning forces.
5.	The entrance canopy is connected to the building along its rear edge but not along the sides. At the rear edge, the canopy frames into the wall below the roof level. There is no mechanism to restrain the rotation of the canopy during an earthquake event. This may result in damage to the beam connections and a loss of gravity support for the canopy.
6.	There is electrical conduit running between the portable units at the roof level without flexible connections. As the buildings move relative to each other during an earthquake, the conduit may be damaged, causing a potential life safety hazard.

10.9 Recommendations

Items listed below follow the same order as the itemized list of deficiencies identified in section 10.8 above.

Item	Recommended Remediation	Priority	Drawing Number
1.	Provide a new metal collector strap above the plywood roof sheathing along the east and west sides of the building.	1.3	2
2.	Add new collector elements, with metal straps over the plywood roof sheathing at the corners of the openings.	1.5	2
3.	Provide a new continuous metal strap above the plywood roof sheathing.	1.3	2
4.	Provide new holdowns at each end of the existing shear walls	1.2	1
5.	Provide new knee bracing at frame at the front of the entrance canopy, OR provide new lateral bracing of the low beam that supports the rear edge of the canopy. This bracing should be connected up to the main roof level.	1.7	2
6.	Relocate conduit or install flexible connections to accommodate relative movement of the buildings.	1.9	None

10.10 Portable Units

In past earthquakes, the predominant damage displayed by portable buildings has been associated with the buildings moving off of their foundations and suffering damage as a result. The portables observed during our site visits tend to have the floor levels close to the ground, thus the damage resulting from buildings coming off of their foundation is expected to be minimal. The life safety risk of occupants would be posed from the potential of falling 3 feet to the existing grade levels during strong earthquake ground shaking. Falling hazards from tall cabinets or bookshelves could pose a greater life safety hazard than building movement. The foundation piers supporting the portable buildings tend to be short; thus the damage due to the supports punching up through the floor if the portable were to come off of its foundation is not expected to be excessive.

Because of their light frame wood construction and the fact that they were constructed to be transported, the portable classrooms are not in general expected to be life safety collapse hazards. In some cases the portables rest directly on the ground and though not anchored to the ground or a foundation system could only slide a small amount. In these instances the building could slide horizontally, but we do not expect excessive damage or life safety hazards posed by structural collapse of roofs.

The regulatory status of portables is not always clear given that portables constructed prior to 1982 will likely have not been reviewed by DSA and thus will likely not comply with the state regulations for school buildings. Portables constructed after about 1982 should have been permitted by DSA. The permits are either issued as temporary structures to be used for not more than 24 months or as permanent structures.

10.11 Structural Deficiency Prioritization

This report hazard rating system is based on a scale of 1.0 to 3.9 with 1.0 being the most severe and 3.9 being the least severe. Based on FEMA 310 requirements, building elements have been prioritized with a low rating of 1.0 to 1.9 if the elements of the building's seismic force resisting systems are woefully inadequate. Priority 1.0 to 1.9 elements could be the causes for building collapses, partial building collapses, or life-safety falling hazards if the buildings were subjected to major earthquake ground motion.

If elements of the building's seismic force resisting system seem to be inadequate based on visual observations, FEMA 310 requirements and limited lateral (seismic) calculations, but DASSE believes that these element deficiencies will not cause life-safety hazards, these building elements have been prioritized between a rating low of 2.0 to 3.9. These elements could experience and / or cause severe building damage if the buildings were subjected to major earthquake ground motion. The degree of structural damage experienced by buildings could cause them not to be fit for occupancy following a major seismic event or even not repairable.

The following criteria was used for establishing campus-phasing priority:

First, the individual element deficiencies which were identified during site visit and review of existing drawings were prioritized with a rating between 1.0 to 3.9 and as described in this section.

Next, based on the school district's budgetary constraints and scheduling requirements, each school campus was given a phasing number between one and three. Phase 1A represents a school campus with severe seismic deficiencies, Phase 1B represents a school campus with significant seismic deficiencies and Phase 2 represents a school campus with fewer seismic deficiencies.

10.12 Conclusions

1. Given the vintage of the building(s), some elements of the construction will not meet the provisions of the current building code. However, in our opinion, based on the qualitative and limited quantitative evaluations, the building(s) will not pose serious life safety hazards if the seismic deficiencies identified in section 10.8 are corrected in accordance with the recommendations presented in section 10.9.

2. Any proposed expansion and renovation of the buildings should include the recommended seismic strengthening presented in section 10.9. Expansion and renovation schemes that include removal of any portion of the lateral force resisting system will require additional seismic strengthening at those locations. It is reasonable to assume that where new construction connects to the existing

building(s), local seismic strengthening work in addition to that described above will be required. All new construction should be supported on new footings.

3. Overall, we recommend that seismic retrofit work for this school campus be performed in Phase 2.

10.13 Limitations and Disclaimer

This report includes a qualitative (visual) level of evaluation of each school building. Numerical seismic analyses of buildings are not included in this scope of work. The identification of structural element code deficiencies based on gravity and seismic analysis demand to capacity evaluations are therefore not included. Obvious gravity or seismic deficiencies that are identified visually during site visits or on available drawings are identified and documented in this report.

Users of this report must accept the fact that deficiencies may exist in the structure that were not observed in this evaluation. Our services have consisted of providing professional opinions, conclusions, and recommendations based on generally accepted structural engineering principles and practices.

DASSE's review of portable buildings has been limited to identifying clearly visible seismic deficiencies observed during our site visit and these have been documented in the report. Portable buildings pose several issues with regard to assessing their life safety hazards. First, drawings are often not available and when they are, it is not easy to associate specific drawings with specific portable buildings. Second, portable buildings are small one story wood or metal frame buildings and have demonstrated fairly safe performance in past earthquakes. Third, there is a likelihood that portable buildings (especially those constructed prior to 1982) are not in compliance with state regulations, either because they were not permitted or because the permit was for temporary occupancy and has expired.

Appendix A - Figures

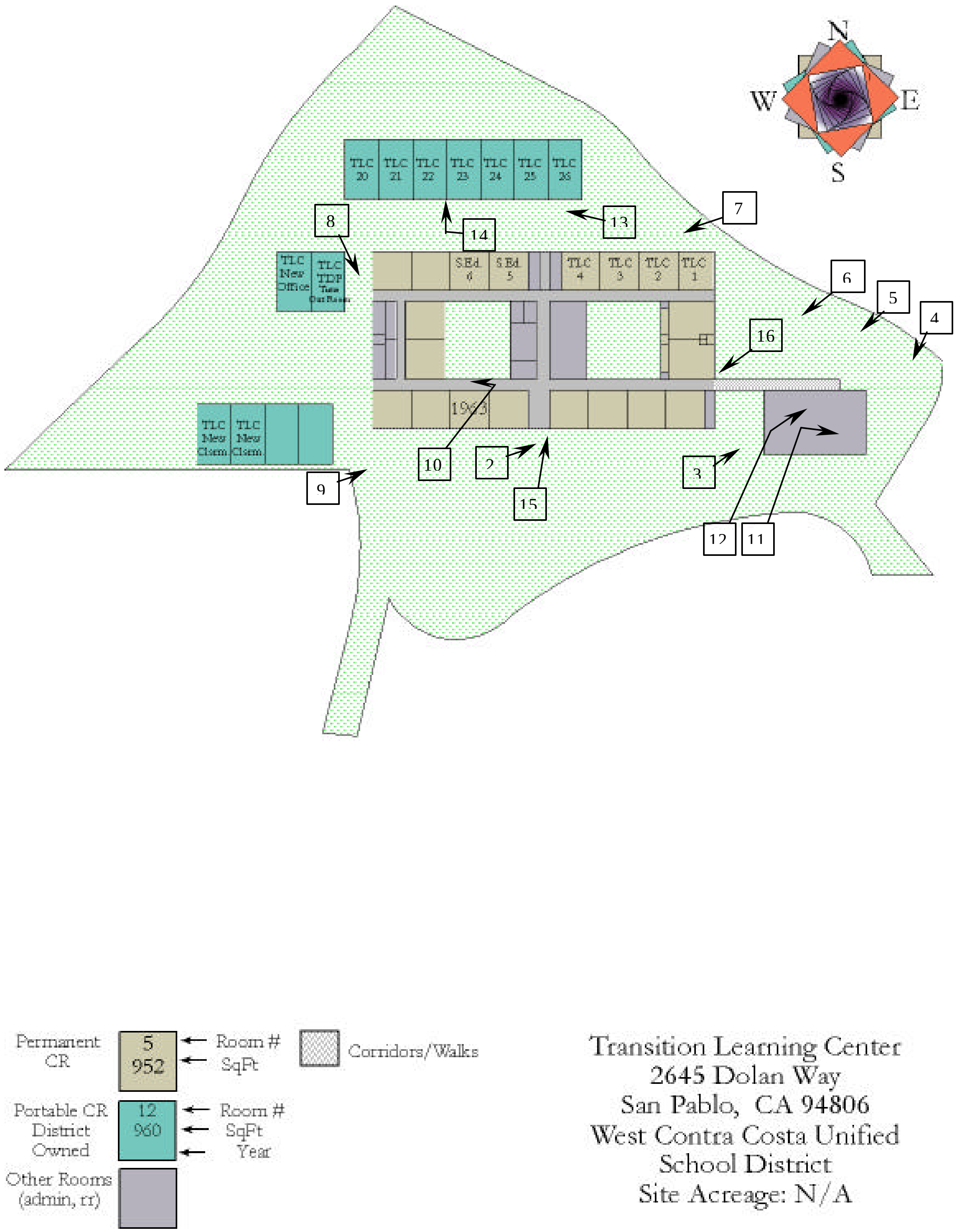


Figure 1: School Layout Plan

Figure 2: South Longitudinal Wall of Main Building (East Half)

Figure 3: South Face of Multi-Purpose Building

Figure 4: East Face of Multi-Purpose Building

Figure 5: North Face of Multi-Purpose Building at Kitchen Area

Figure 6: East Face of Main Building

Figure 7: North Longitudinal Wall of Main Building

Figure 8: West Face of Main Building

Figure 9: South Longitudinal Wall of Main Building (West Half)

Figure 10: Interior Corridor of Main Building at Courtyard Windows

Figure 11: Interior of Multi-Purpose Building Looking at Stage

Figure 12: Interior of Multi-Purpose Building Looking at Kitchen Area

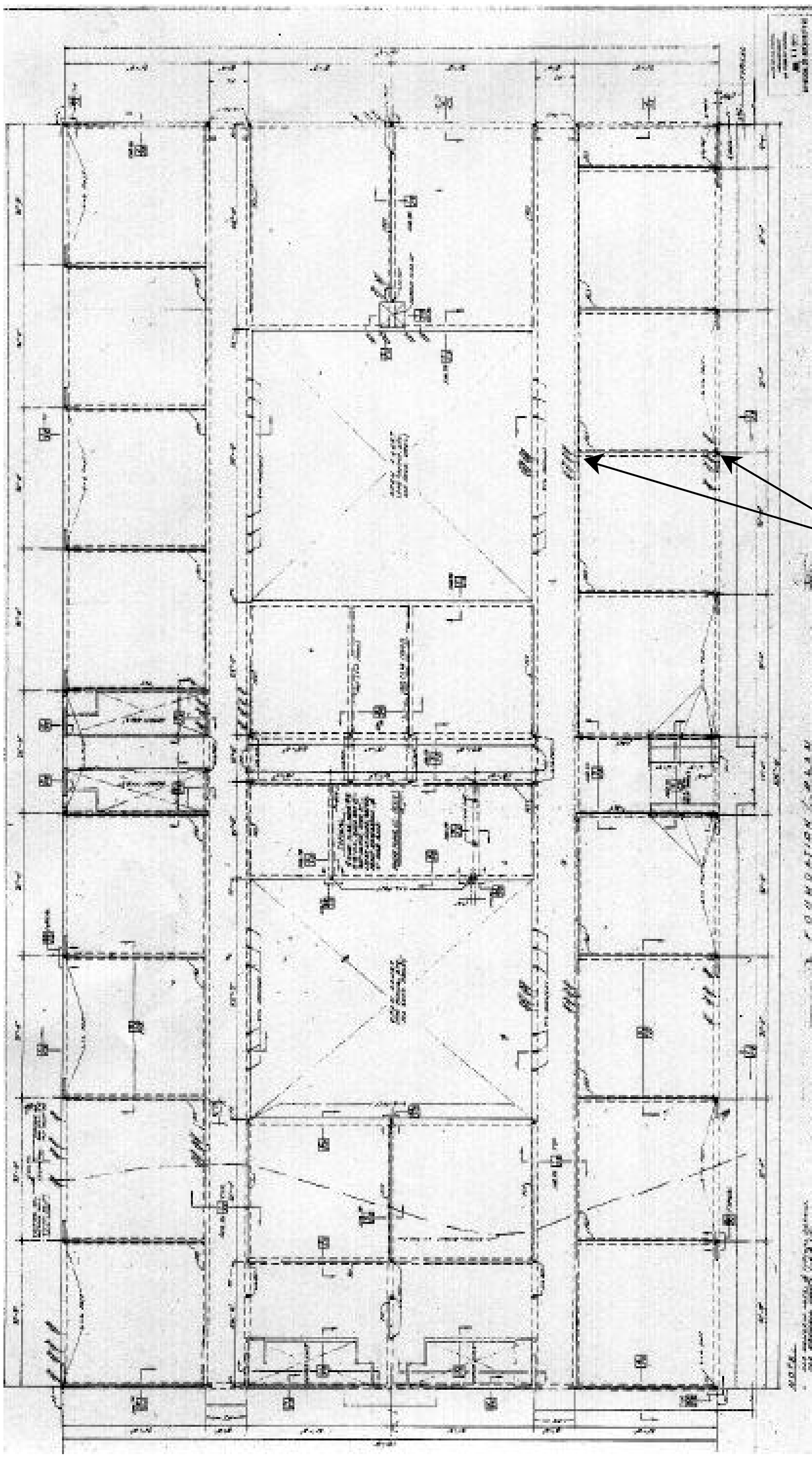
Figure 13: Portable Classrooms

Figure 14: Conduit Running between Portable Classrooms

Figure 15: Entrance Canopy at Main Building

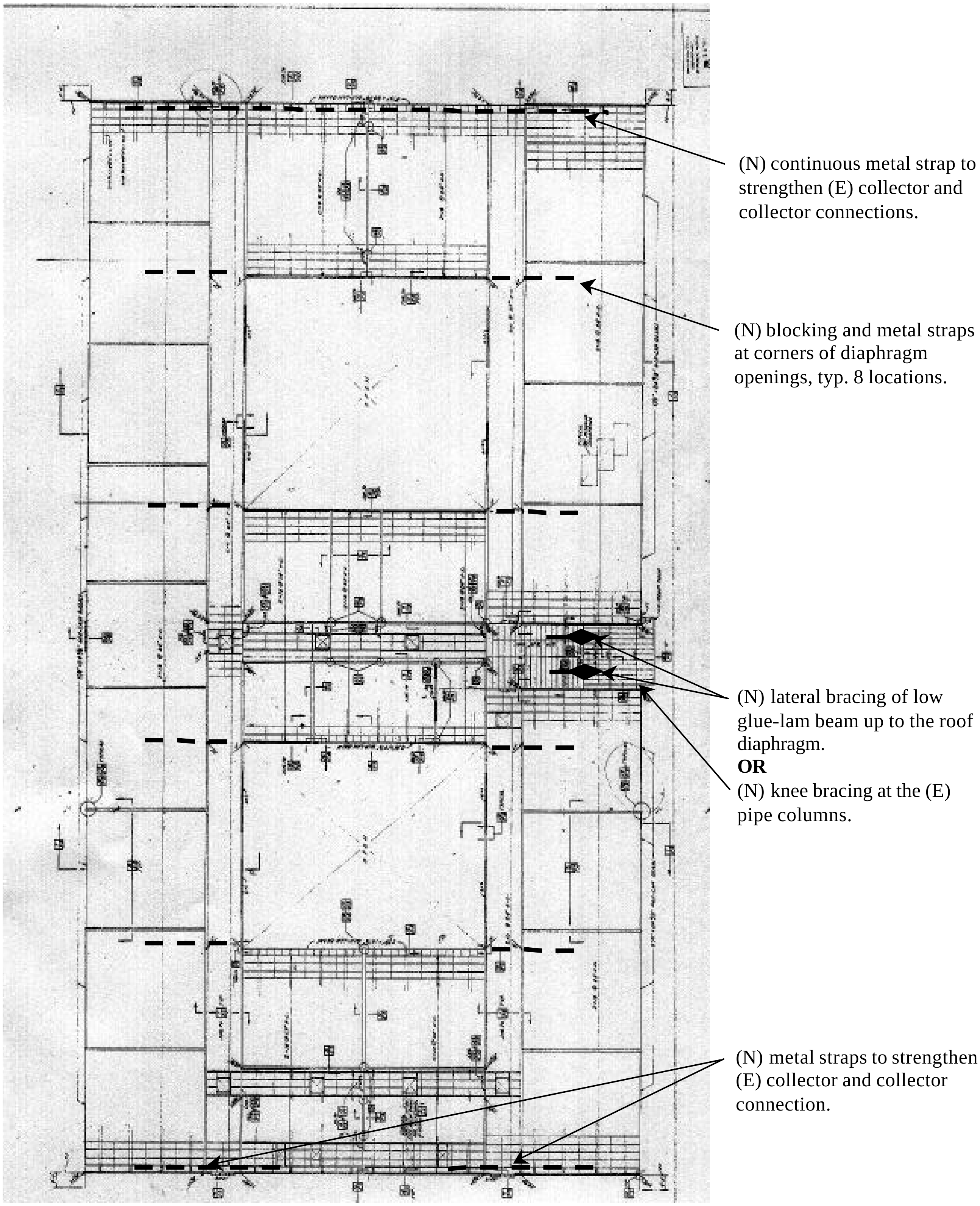
Figure 16: Seismic Joint at Corridor near Main Building

Appendix B - Drawings

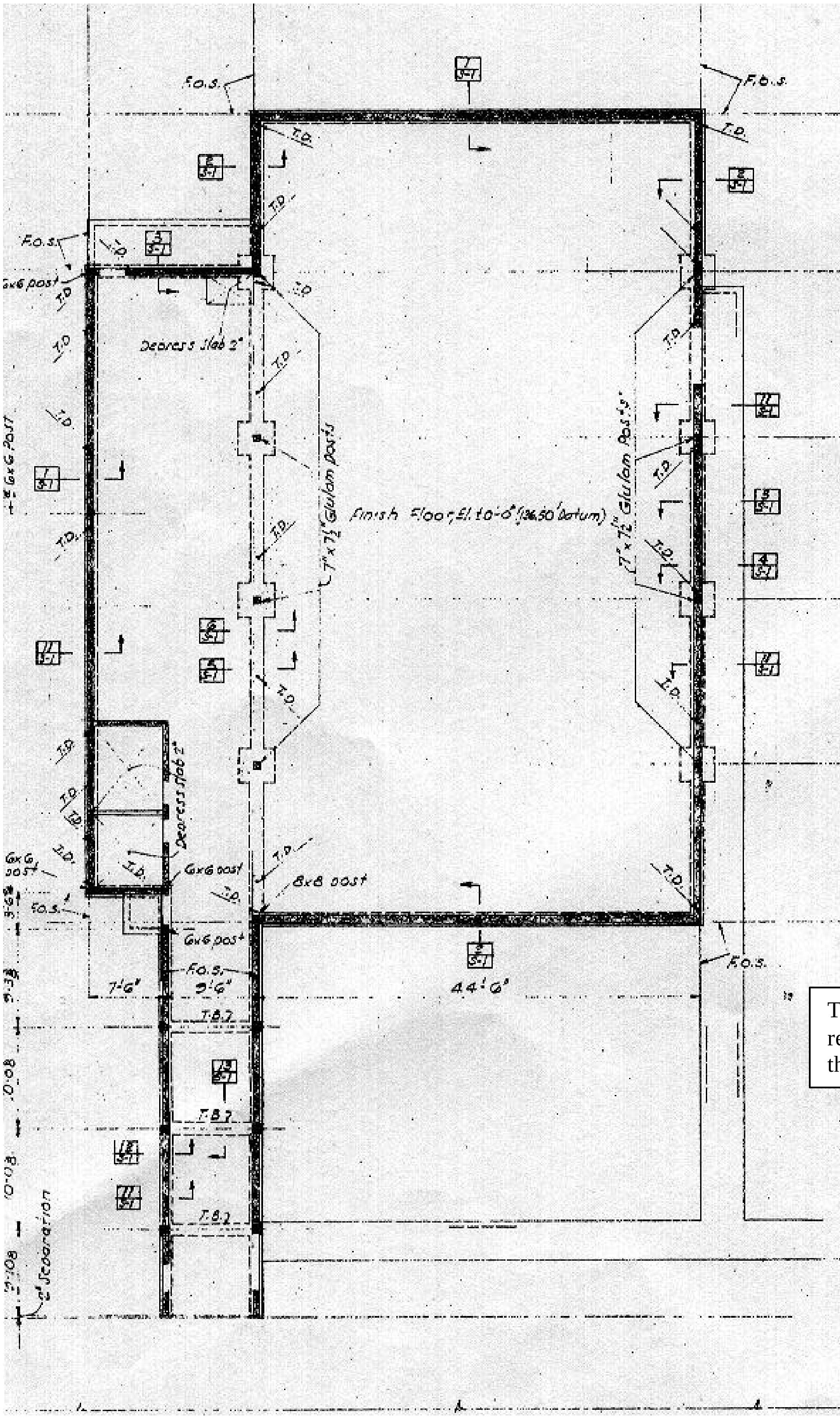


(N) holdowns at the ends of shear walls, typ. at all transverse shear walls.

Drawing 1: Main building floor plan

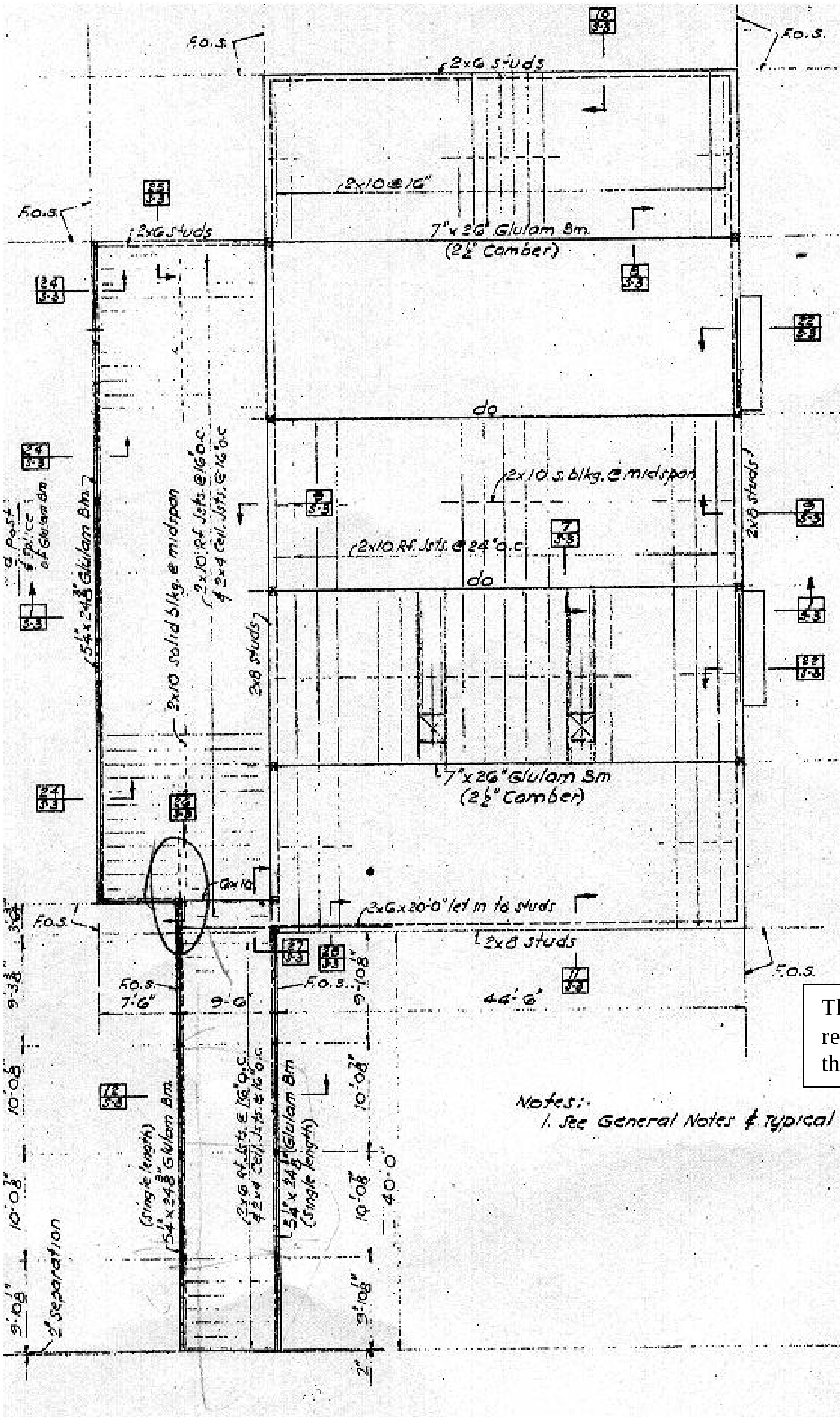


Drawing 2: Main building roof plan



There is no seismic retrofit work recommended for this building at the foundation level.

Drawing 3: Multi-purpose building floor plan



There is no seismic retrofit work recommended for this building at the roof level.

Drawing 4: Multi-purpose building roof plan