Ninth Avenue Pier Renovation
Oakland, CA

STRUCTURAL FEASIBILITY STUDY

Prepared for Submittal to:

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PROJECT DESCRIPTION

The existing 9th Ave Pier Transit Shed Buildings within the Port of Oakland consist of a one-story shed building with an enclosed area of approximately 142000 square feet built in 1929 with additions in 1950. The buildings are currently being used to store bails of cotton. Signature Properties proposes to convert the two pier shed buildings into a mixed occupancy facility.

The purpose of this feasibility study is to provide Signature Properties with schematic seismic rehabilitation details for the pier shed buildings.

ACCEPTANCE CRITERIA

GOVERNING CODES

Currently, both the 1950 and 1929 Transit Shed Buildings are not historic structures. The governing code for these buildings is the 2001 California Building Code and specifically chapter 34 entitled "Existing Structures". Were the buildings given Historic Structure status, the governing Code for the project would be the *California Historical Building Code*, Part 8, C.C.R. (CHBC), adopted June 23, 1998. In particular, the Alternative Structural Regulations in Chapter 8-5 of the CHBC would apply.

PERFORMANCE OBJECTIVES

Our study is based on the assumption that the building will need to provide minimum life safety in the case of a major earthquake. Therefore, we have conducted a performance based analysis of the building using the criteria contained in FEMA 356 for the Structural Life Safety (S-3) performance level for an earthquake with a 10% probability of exceedance in 50 years (a probabilistic approach). FEMA 356 is an industry accepted standard for performance based design of existing buildings and provides for the intended performance of both the UBC and CHBC with regard to minimum life safety. Per FEMA 356 the life safety performance is described as:

> "C1.5.1.3 Life Safety Structural Performance Level (S-3).
>
> Structural Performance Level S-3, Life Safety, means the post-earthquake damage state in which significant damage to the structure has occurred, but some margin against either partial or total structural collapse remains. Some structural elements and components are severely damaged, but this has not resulted in large falling debris hazards, either within or outside the building. Injuries may occur during the earthquake; however, the overall risk of life-threatening injury as a result of structural damage is expected to be low. It should be possible to repair the structure; however, for economic reasons this may not be practical. While the damaged structure is not an imminent collapse risk, it would be prudent to implement structural repairs or install temporary bracing prior to reoccupancy."

EVALUATION APPROACH

The truss moment frame rehabilitation options for the Transit Shed Buildings were evaluated based on a Nonlinear Static Pushover analysis and FEMA 356 Life Safety performance criteria. The longitudinal concrete shear walls and clear story wood shear walls of the Transit Shed Buildings were evaluated based on 100% of the 1997 UBC seismic base shear.

SUMMARY OF STRUCTURAL DEFICIENCIES

PIER SHED BUILDINGS

While the existing structural system is in generally good condition, there is some deterioration present in the exterior longitudinal concrete walls. Cracks, spalled concrete, and exposed and corroding reinforcing steel occur sporadically throughout the extent of the walls. The longitudinal concrete walls have adequate strength to resist the in-plane seismic forces. The existing steel truss frames are in excellent condition. However, the frames will exhibit very poor post-yield behavior and are a potential collapse hazard. Neither the transverse frames, their anchorage to the pier deck, the longitudinal clerestory straight sheathed shear walls, nor the existing straight sheathed roof diaphragm have adequate capacity to resist the in-plane seismic forces. In addition to in-plane structural deficiencies, the existing connection of the roof diaphragm to the concrete walls does not provide adequate support of the concrete walls for out-of-plane seismic forces.

SUMMARY OF PROPOSED STRUCTURAL SEISMIC UPGRADES

PIER SHED BUILDINGS

Two upgrade alternatives are summarized below (please note that these alternatives can be combined, i.e. portions of the buildings could be upgraded using either alternative):

Mezzanine Alternative

1. Addition of approximately 70,000 sf. of new steel framed second floor area for the 1929 section and 72,000 sf of new steel framed second floor area for the 1950 section (see sketch SK-14 through SK-17).

2. Addition of new steel diagonal braced frames in the lower level of the renovated building, between the pier deck and the new second floor. The braces will be added in line with approximately every third steel truss-frame in the transverse (north-south) direction. These braces provide increased lateral force capacity to augment the existing steel truss-frames as the primary lateral seismic resisting system of the structure (see sketch SK-14 through SK-17).

3. Addition of new concrete beams to the pier deck under the new columns and diagonal braces to transfer gravity and seismic overturning loads to the existing piles (see sketch SK-14 through SK-17).

4. Addition of new plywood sheathing over the existing straight sheathing to increase the shear wall lateral load resisting capacity at clerestory between the high roof and low roof in the longitudinal direction (see sketch SK-10 through SK-12).

5. Increase the ductility of each truss moment frame in the transverse direction by replacing existing riveted connections with new slip connections at the ends of selected truss diagonals (see SK-10, SK-11, and SK-13).

6. Strengthening of the anchorage of the existing columns at the new braced frame locations. Also, removal of the existing concrete bumpers/pedestals under the existing interior columns and extending the steel columns down to the concrete deck (see sketch SK-10 and SK-11).

7. Addition of new plywood sheathing over the existing straight sheathing to increase the roof diaphragm lateral load resisting capacity (see sketch SK-04).

8. Addition of new wood blocking between the roof sheathing and every truss-frame in the transverse direction to strengthen the lateral load transfer mechanism (see sketch SK-04 and SK-09).

9. Addition of new roof purlins and wall ties at 12-ft on center along the perimeter of the buildings to strengthen the attachment of concrete walls to roof diaphragm for out-of-plane seismic forces (see sketch SK-04, SK-07, and SK-08).

10. Addition of new chord bracing to increase lateral resisting capacity of existing truss moment frames in the transverse direction (see sketch SK-05 and SK-06).

11. Repair of all deteriorated conditions at the exterior concrete walls.

Trussed Column Alternative

1. Strengthen each existing concrete column in the transverse direction with additional steel elements to improve lateral load resisting capacity of the truss-frames (see sketch SK-10 for 1929 Building and SK-11 for 1950 Building).

2. Addition of new plywood sheathing over the existing straight sheathing to increase the shear wall lateral load resisting capacity at clerestory between the high roof and low roof in the longitudinal direction (see sketch SK-10 through SK-12).

3. Increase the ductility of each truss moment frame in the transverse direction by replacing existing riveted connections with new slip connections at the ends of selected truss diagonals (see SK-10, SK-11, and SK-13).

4. Strengthening of the anchorage of the existing columns at the new braced frame locations. Also, removal of the existing concrete bumpers/pedestals under the existing interior columns and extending the steel columns down to the concrete deck (see sketch SK-10 and SK-11).

5. Addition of new plywood sheathing over the existing straight sheathing to increase the roof diaphragm lateral load resisting capacity (see sketch SK-04).

6. Addition of new wood blocking between the roof sheathing and every truss-frame in the transverse direction to strengthen the lateral load transfer mechanism (see sketch SK-04 and SK-09).

7. Addition of new roof purlins and wall ties at 12-ft on center along the perimeter of the buildings to strengthen the attachment of concrete walls to roof diaphragm for out-of-plane seismic forces (see sketch SK-04, SK-07, and SK-08).

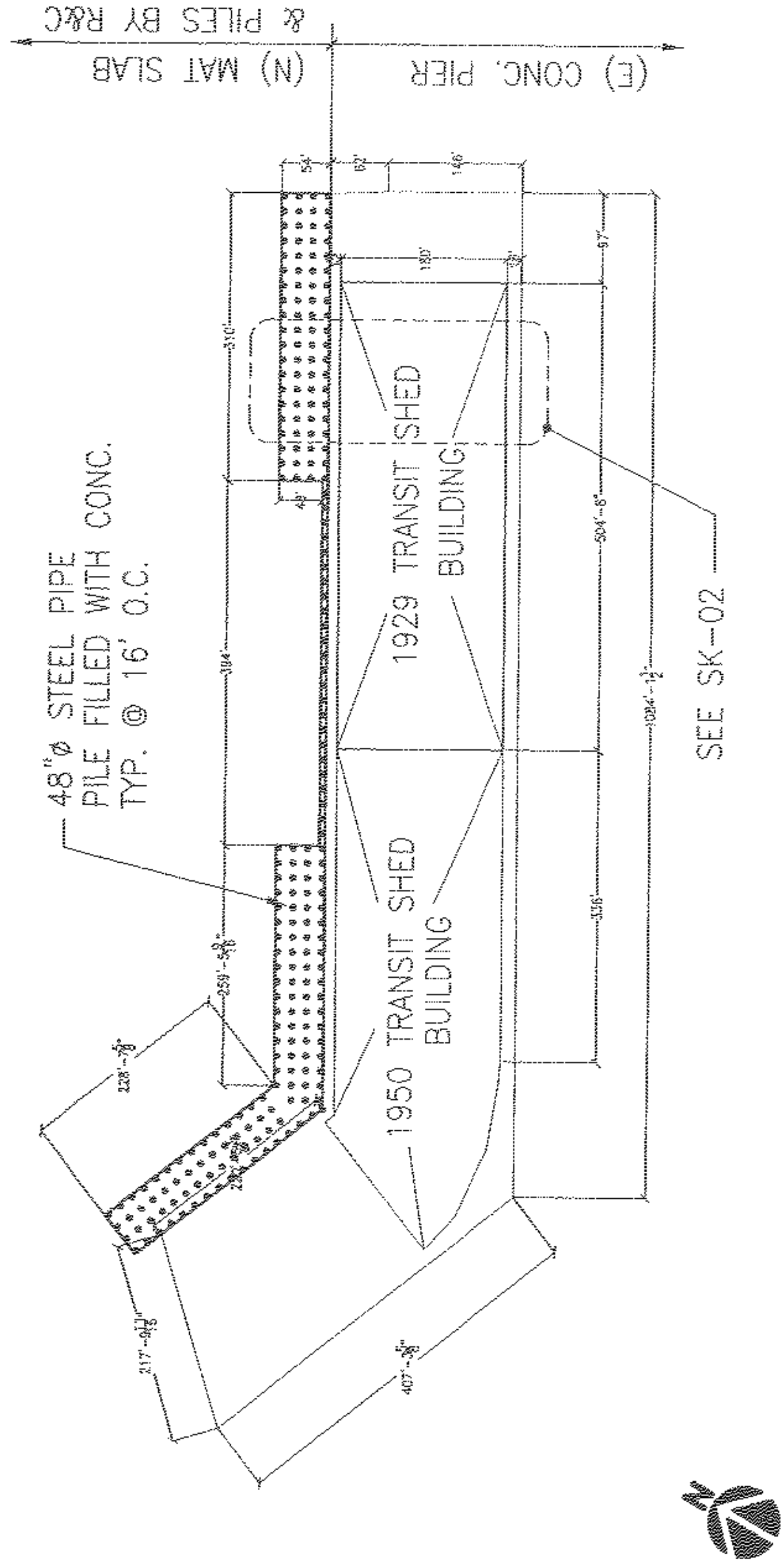
8. Addition of new chord bracing to increase lateral resisting capacity of existing truss moment frames in the transverse direction (see sketch SK-05 and SK-06).

9. Repair of all deteriorated conditions at the exterior concrete walls.

RUTHERFORD & CHEKENE

SKETCHES

Ninth Avenue Pier Renovation
Oakland, CA



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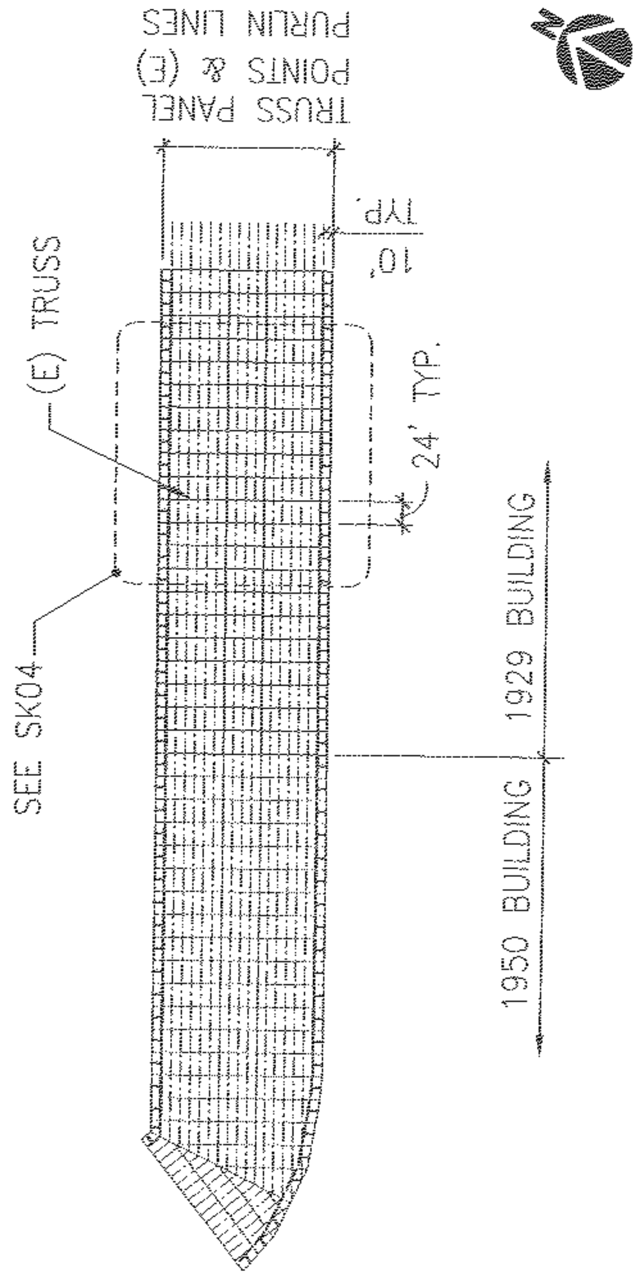
9TH AVENUE TERMINAL

PLAN OF NEW/EXISTING CONCRETE PIER AND TRANSIT SHED BUILDING

SK01A

JOB No.: 2001142S	BY: DSB	SCALE: 1"=200'	DATE: 02-22-02



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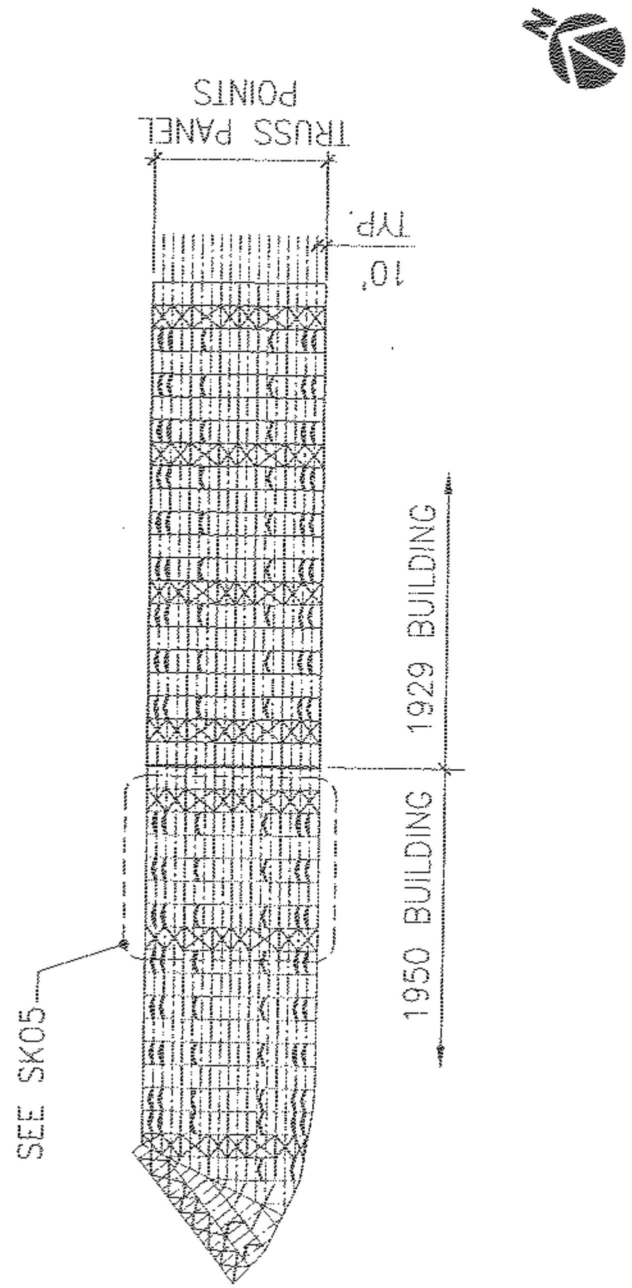
9TH AVENUE TERMINAL

ROOF PLAN

SK01B

JOB No.: 20011425 | BY: DSB | SCALE: 1"=200' | DATE: 02-22-02



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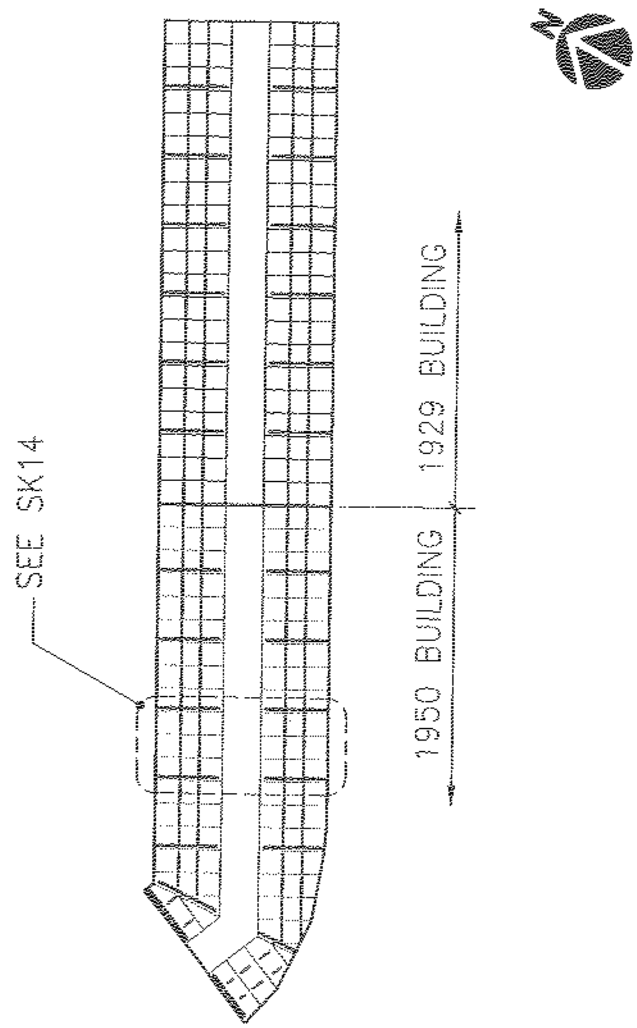
9TH AVENUE TERMINAL

TRUSS BOTTOM CHORD PLAN

SK01C

JOB No.: 2001142S	BY: DSB	SCALE: 1"=200'	DATE: 02-22-02



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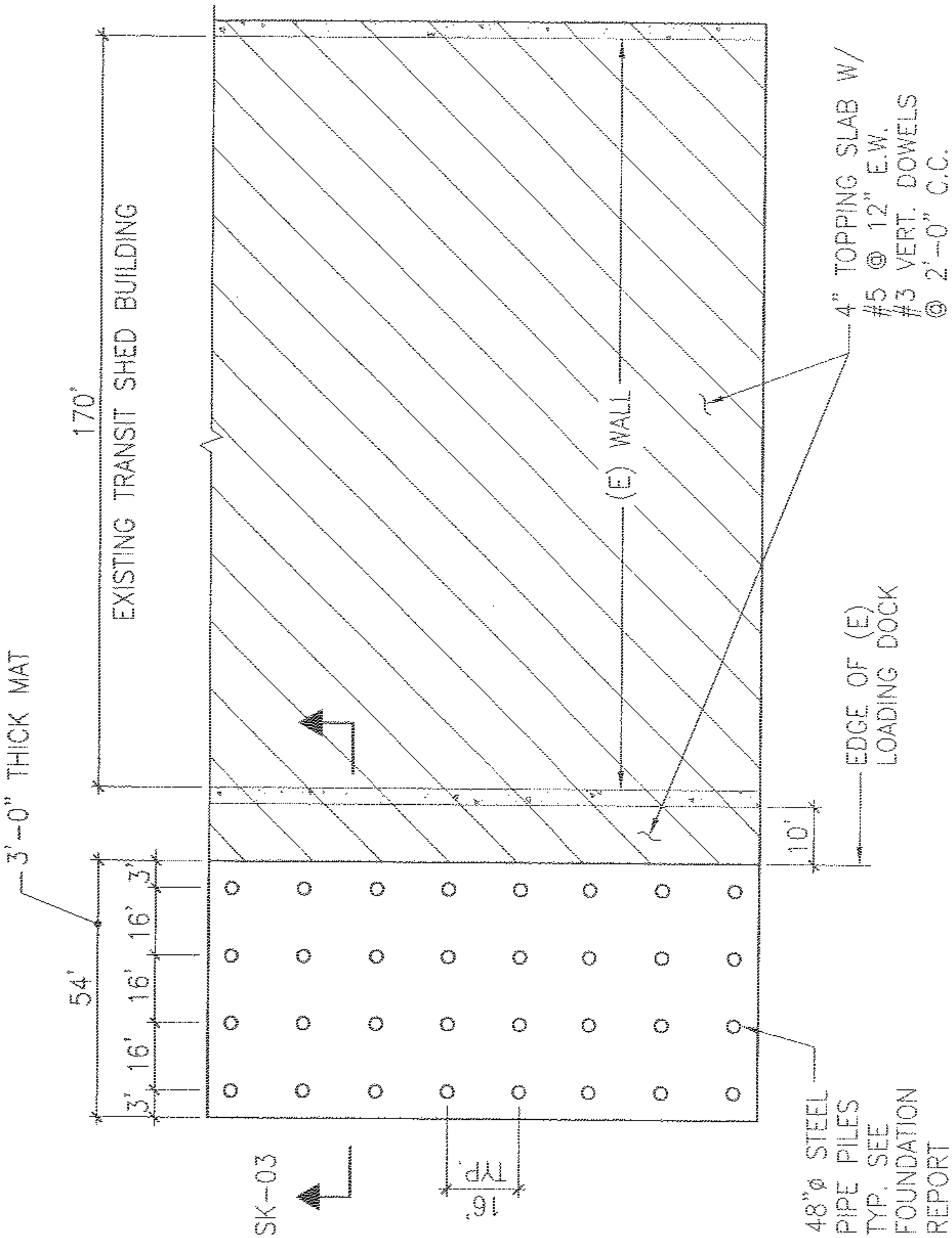
9TH AVENUE TERMINAL

MEZZANINE PLAN

SK01D

JOB No.: 2001142S	BY: DSB	SCALE: 1"=200'	DATE: 02-22-02



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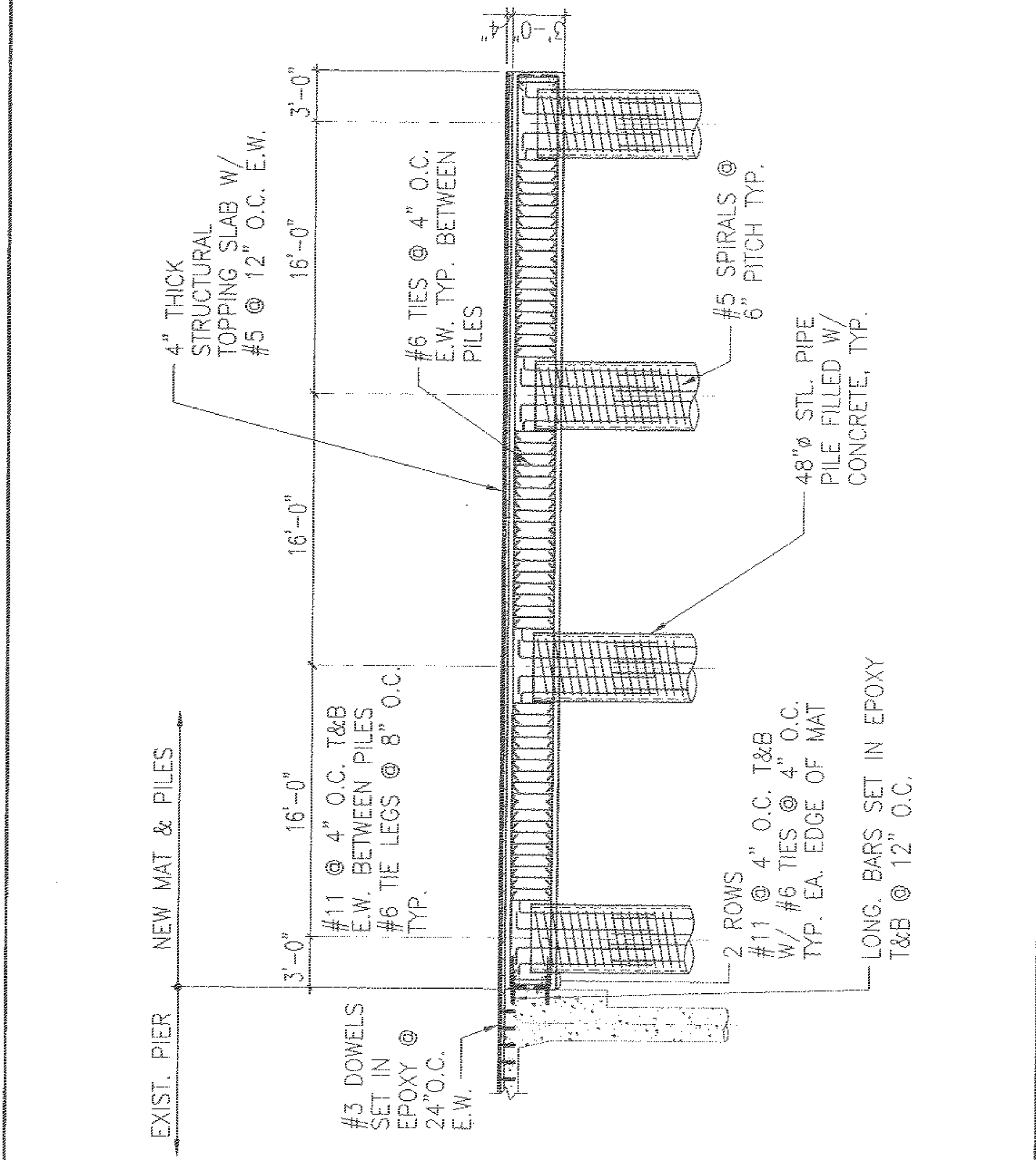
9TH AVENUE TERMINAL

PARTIAL PLAN OF NEW/EXISTING CONCRETE PIER

SK02

JOB No.: 2001142S	BY: DSB	SCALE: NO SCALE	DATE: 02-22-02



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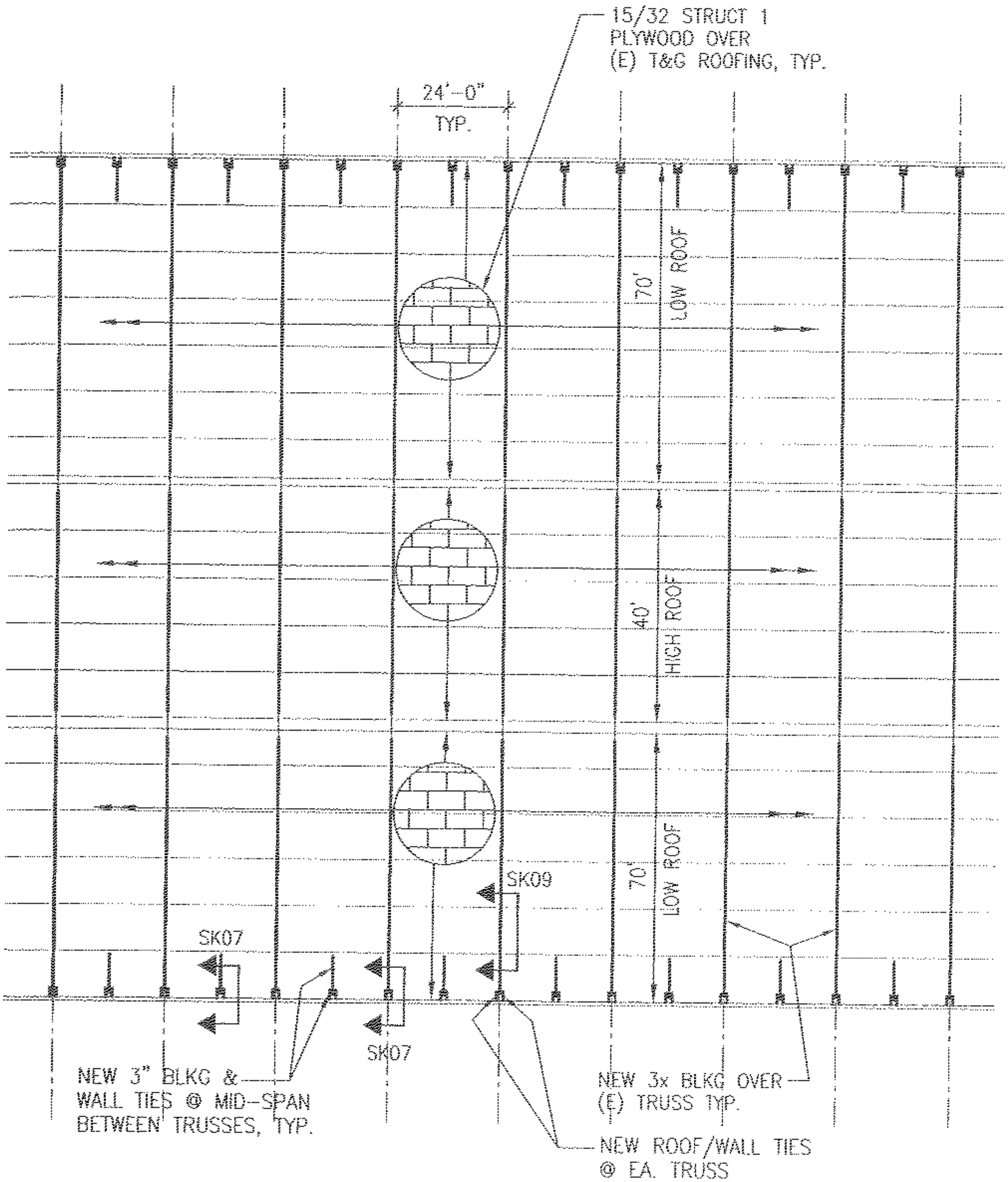
9TH AVENUE TERMINAL

SECTION THROUGH NEW MAT SLAB & PILES

SK03

JOB No.: 2001142S	BY: DSB	SCALE: 1/8"=1'-0"	DATE: 02-22-02



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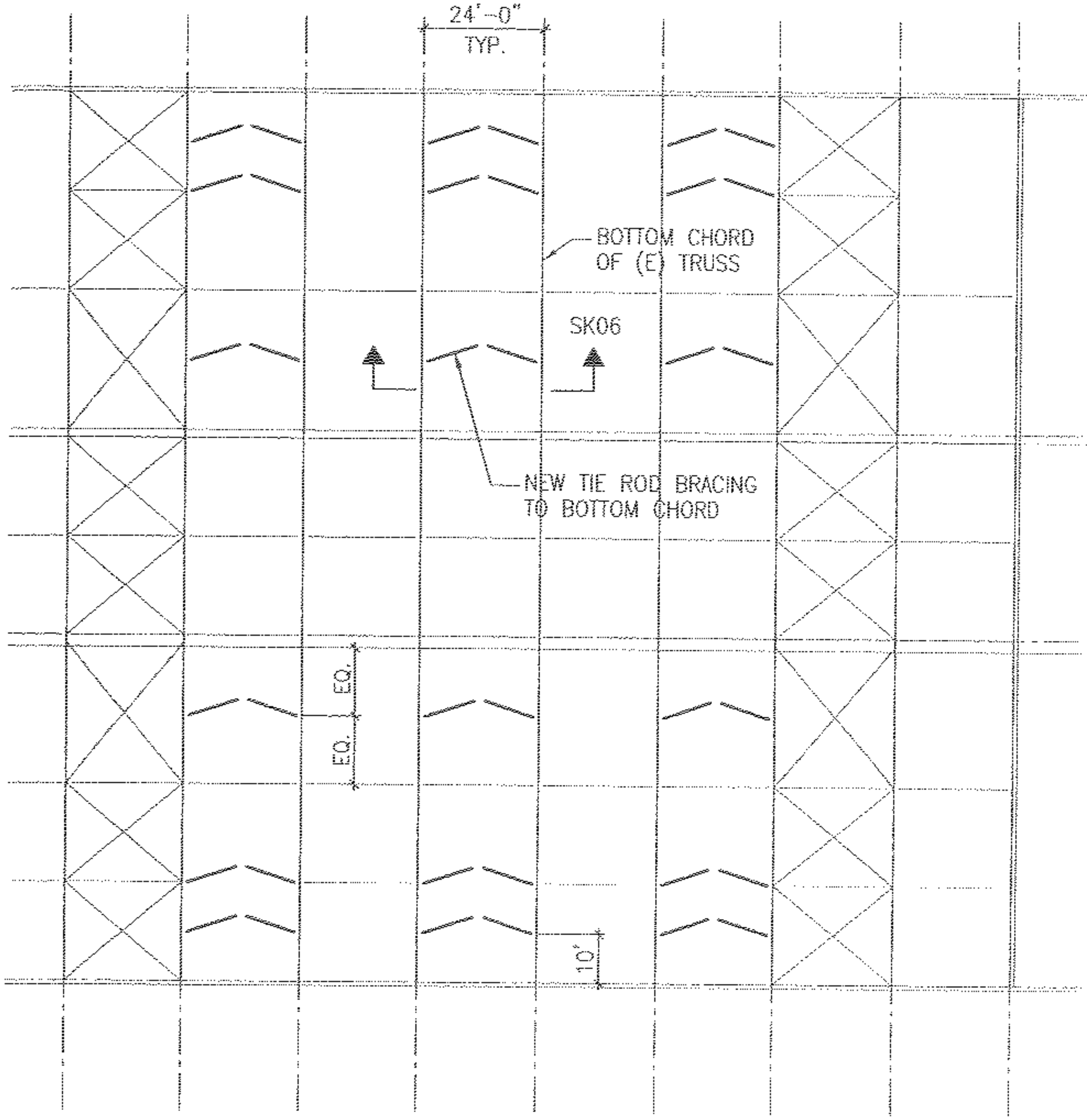
9TH AVENUE TERMINAL

PARTIAL PLAN OF ROOF

SK04

JOB No.: 2001142S	BY: DSB	SCALE: 1/32"=1'–0"	DATE: 02–22–02



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9TH AVENUE TERMINAL

PARTIAL PLAN OF TRUSS BOTTOM CHORD

SK05

JOB No.: 2001142S	BY: DSB	SCALE: 1/32"=1'-0"	DATE: 02-22-02