CONCEPTUAL AERIAL STRUCTURAL STUDY

DECEMBER 23, 1986

Prepared for

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

by

METRO RAIL TRANSIT CONSULTANTS

Los Angeles, California

① N. TAHIR
② B. Feng
③ file CORE

METRO RAIL TRANSIT CONSULTANTS
DMJM / PBQD / KE / HWA

12-30-86

December 24, 1986

Mr. Robert J. Murray
Assistant General Manager
Southern California Rapid Transit District
Transit Systems Development
425 South Main Street
Los Angeles, California 90013

Subject: Conceptual Aerial Structural Study

Purpose: Information Transmittal

File No: P001X011

Dear Mr. Murray:

Enclosed for your information and use is the final report of the subject study.

METRO RAIL TRANSIT CONSULTANTS

Howard J. Chaliff
Project Director

HJC:KNM:djr

Enclosure

cc: J. E. Crawley, SCRTD
J. Christiansen, SCRTD
J. Kirinich, SCRTD
M. Polacek, PDCD

TABLE OF CONTENTS

Figure

Table

List of Appendixes

1.0 PURPOSE

The purpose of this conceptual study is to investigate and establish, in more detail, the requirements for aerial guideway construction. This includes determining structural feasibility, aesthetic appeal, economic viability, and constructibility of various aerial structure types.

A section of the proposed aerial structure along Vermont Avenue was evaluated. The study that follows describes the elements that were used to determine a conceptual per-foot cost for the typical aerial structure.

Sheet surface restoration and new construction of curbs, gutters, and sidewalks are based on minimum requirements in order to maintain existing traffic lanes while providing a 12-foot median strip for column support structures.

Relocation of utilities is based on minimum requirements for relocating those facilities which conflict with the structure footing.

We have reviewed the structural feasibility, aesthetic appeal, economic viability, and constructibility of various aerial structure types. The study considers alternative construction materials, including steel, precast concrete, poured-in-place oncrete, and combinations thereof.

To aid in this study, we have performed a preliminary investigation of heavy rail aerial structures constructed in other cities of the United States, e.g., Atlanta, Baltimore, Miami, San Francisco, and Washington, D.C. Structural concepts used at such transit properties are shown for comparison.

2.0 SUMMARY OF TYPICAL PAVING REQUIREMENTS ALONG VERMONT AVENUE

2.1 Purpose

The purpose of studying a proposed aerial structure which would accomodate existing traffic along a typical section of Vermont Avenue was to evaluate costs and arrive at a basis for construction estimates.

2.2 Existing Conditions

Vermont is a paved street, 70 feet from curb to curb with a 15-foot sidewalk pattern on each side.

There are three 10-foot lanes in each direction. Each center 10-feet lane is used for left-turn lanes at intersections, as well as for "holding" left turns into driveways at midblock. (See typical Section, Figure 1.)

2.3 Proposed Construction

The aerial structure would be built on the center line of the street within a 12-feet median, and would be supported by a column 7 feet in diameter.

To provide a left turn "pocket" at designated cross streets, the adjacent traffic would be directed to the right until a 9-foot offset was reached. The 9-foot offset would become the left-turn pocket.

Past the left-turn intersection, traffic is diverted back to the left. The length of diversion at 10:1 is ±90 feet. Adding an average of 200 feet for length-of-turn pockets makes the entire diversion approximately 300 feet long.

Where no diversion is required, the existing sidewalk, curb, and gutter could remain. On an average, 60 percent of the existing curb, gutter, and sidewalk would remain.

It is assumed that where possible existing pavement would be reused with a 2-inch overlay. Other new pavement would require 8-inch AC (including a 2-inch wearing surface) on a 6-inch crushed aggregate base.

The center median would be two rows of concrete curb separated by AC pavement (2 inches thick on a 6-inch crushed aggregate base).

2.4 Approximate Quantities to be Considered for Concept Estimates

A. Total development per foot of length at left-turn lanes:

1. Left side of existing curb and gutter to remain as is

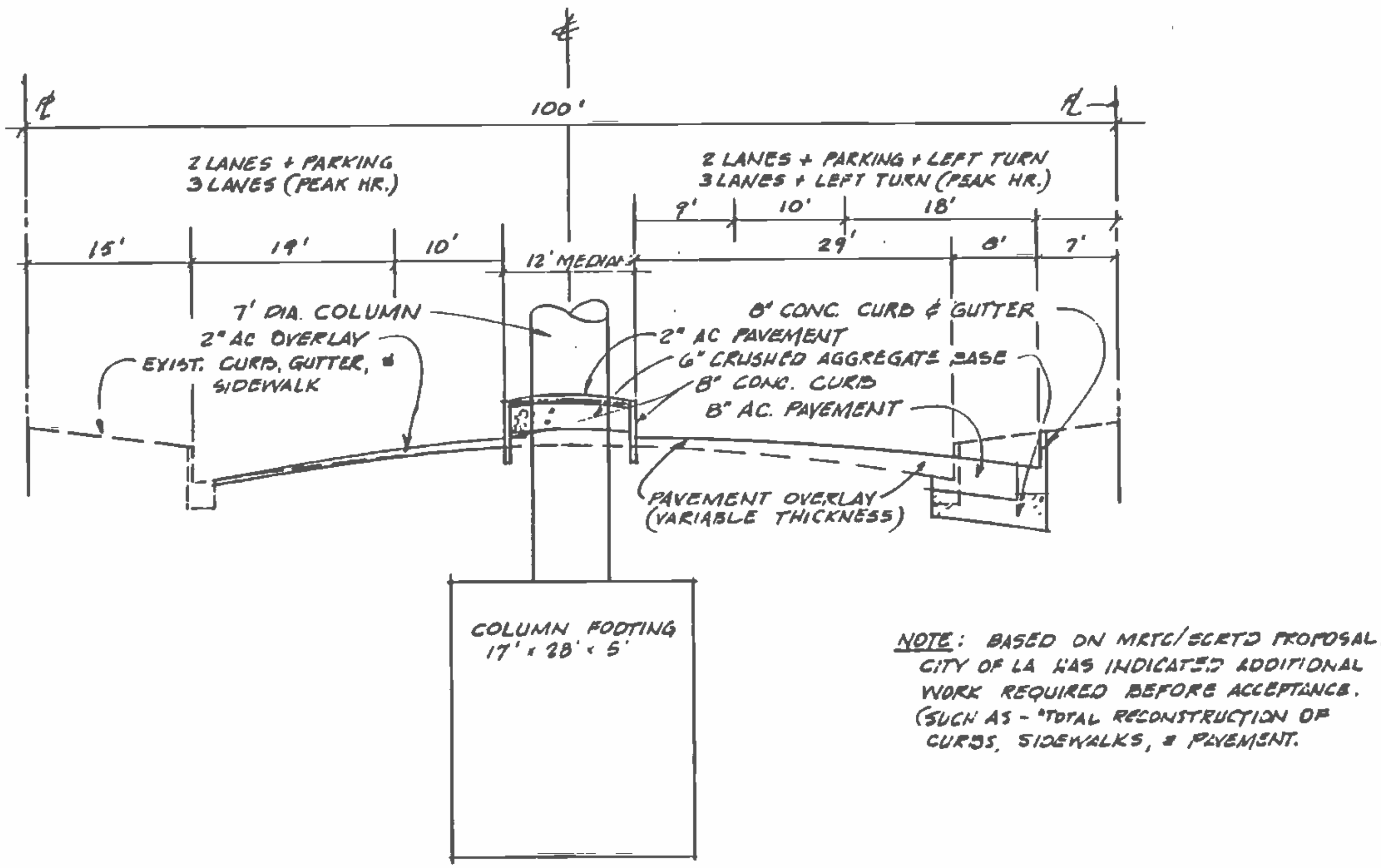


Figure 1: TYPICAL SECTION - VERMONT AERIAL STRUCTURE

2. Two-inch overlay of AC to median (29 feet)

3. Eight-inch curb (2 each)

4. Two-inch AC on 6-inch base (11 feet)

5. Two inches of AC to remain (29 feet)

6. New 8 inches of AC on 6-inch base (8 feet)

7. New 8-inch curb and gutter (1 each).

B. Where no left-turn lane exists:

1. Same as above

2. Same as above

3. Same as above

4. Same as above

5. Same as above

6. Right side curb and gutter to remain as is.

2.5 Conclusion

It is assumed that the construction at left turn lanes, as in A above, would comprise 40 percent of the linear construction. The remaining 60 percent would be as in B above. Therefore, the average quantity per linear foot of improvements would be as follows:

A. Two inches of AC overlay (finish surface) = 69 sq. ft/ft: approximately 8 sq. yds/ft.

B. Eight inches of concrete curb = 2.4 linear ft/ft: approximately 3 linear ft/ft.

C. Six inches of crushed aggregate base = 10.2 sq. ft/ft: approximately 1 sq. yd/ft.

D. Eight inches of AC (new paving) = 3.2 sq. ft/ft: approximately 1/3 sq. yd/ft.

3.0 SUMMARY OF POTENTIAL UTILITY CONFLICTS ALONG VERMONT AVENUE

3.1 Purpose

The purpose of this study was to evaluate costs for an aerial structure along Vermont Avenue, in which, using city-supplied maps, existing utilities were considered and conflicts were identified.

3.2 Transition Structure

Transition was from subway to aerial structure, with a 36-foot-wide U-wall section and a retaining wall of approximately the same width, including wall footings.

3.3 Potential Conflicts with Existing Utilities

A. Third Street to Second Street

Length	Utility	Size	Distance From Street Center Line
235 feet	Water main (DWPWS)	30 inches	16 feet east
235 feet	Sewer (abandoned)	8 inches	13 feet west
235 feet	Water main (DWPWS)	6 inches	18 feet west
220 feet	Sewer	8 inches	20 feet east
235 feet	Telephone ductbank (SCT)	5 PP	22 feet west

B. Second Street to First Street

Length	Utility	Size	Distance From Street Center Line
435 feet	Water main (DWPWS)	30 inches	16 feet east
120 feet	Sewer (abandoned)	8 inches	13 feet west
435 feet	Water main (DWPWS)	6 inches	20 feet west
20 feet	Sewer	8 inches	20 feet east
435 feet	Telephone ductbank (SCT)	5 PP	22 feet west
---	Elec. vault with ductbank bypass (2-6 inches)		19 feet east
---	Telephone manhole (SCT)		25 feet west

C. Aerial Structure - Twenty-eight foot-wide aerial structure on a single pier supports footings that are 15 feet by 28 feet by 5 feet. The foot is supported by 26 to 30 piles that are 45 feet to 50 feet long. The supports are spaced from 80 to 120 feet apart. Footings at the aerial stations are 21 feet by 32 feet by 5 feet 6 inches and require from 34 to 38 piles. The span lengths are reduced to about 50 feet.

3.4 Potential Conflicts With Utilities

A. Thirty-Inch Water Main

Continuous conflict from 435 feet south of First Street to Rosewood Avenue south of the Hollywood Freeway (16 feet east of the street center line). The water main shifts away from the street center line across the freeway and back (14 feet east of street center line) immediately north of the freeway. The main continues all the way past Hollywood Boulevard, and records show it to be a 36-inch main north of Santa Monica Boulevard.

B. Four-Inch Gas Main

Conflicts with five piers north of First Street (13 feet east of street center line).

C. Eight-Inch Sanitary Sewer (Abandoned)

Conflicts with all piers from First Street to the Hollywood Freeway (on center line).

D. Six-Inch Water Main

Continuous conflict from First Street to the Hollywood Freeway (15 feet from the street center line).

E. Telephone Ductbank and Manholes - 4 MTD & 1 PP

Continuous conflict from First Street to Beverly Boulevard (15.5 feet from the center line of the street).

F. Telephone Ductbank and Manholes - 5 PP

Continuous conflict from Beverly Boulevard to Rosewood Avenue (south of freeway), 165 feet from the center line of the street. The ductbank starts again just north of the freeway and extends to Monroe Street with six ducts and to Willowbrook Avenue with seven ducts. It then decreases to six ducts (6 MTD) and continues northward.

G. Electrical Ductbank With Manholes

Starting at Lockwood and extending northward, this electrical ductbank is generally located five feet east of the street center line and directly conflicts with the proposed footings. It includes 4 five-inch ducts and 4 to 8 four-inch ducts. North of Vermont Place, the ductbank shifts 18.5 feet east of the street center line.

H. Fifty-Four-Inch Storm Drain

Starting at Monroe and extending northward to Willowbrook, there is a 54-inch storm drain 20 feet east of the street center line. It may conflict with the construction of the pier footings but not with their actual location. The storm drain reduces to a 48-inch pipe at Willowbrook and extends to Vermont Place, where it shifts to an alignment only seven feet east of the street center line and extends northward.

I. Individual Service Laterals

The exact location of each building service is not known, but they are numerous, so there will be some in conflict with the final footing locations; however, they can be moved at relatively low cost.

4.0 AERIAL STRUCTURE

4.1 Introduction

The objective of this aerial structural conceptual study is to determine structural feasibility, aesthetic appeal, economic viability, and constructability of various aerial structure types. This study considers alternative materials of construction, including steel, precast concrete, poured-in-place concrete and combinations thereof. We have performed a preliminary investigation of the heavy rail aerial structures constructed in other cities of the United States, e.g., Atlanta, Baltimore, Miami, San Francisco, and Washington, D.C., to aid in this study.

This part of the study addresses candidate Alignment J, which consists of a combination of aerial, retained cut, retained fill (transition structure), and subway sections. Alignment J would include 13.4 miles of subway with 12 stations and 7.1 miles of aerial guideway (including transition structures) with 7 stations, for a total of 20.5 miles and 19 stations.

Alignment J branches to the North after the Wilshire/Vermont Station. It would include a transition from underground subway to an aerial alignment at Vermont Avenue from First Street, and then traverse north along Vermont Avenue and west on Hollywood Boulevard to Bronson Avenue, where it would make a transition back to underground subway and turn north into the San Fernando Valley. The proposed abutments would be located north of First Street and south of Bronson Avenue. The west portion of this alignment would include an underground subway along Wilshire Boulevard to the vicinity of Crenshaw Boulevard, where transition would be made to an aerial profile, and continue in an aerial configuration along Wilshire Boulevard to Fairfax Avenue.

4.2 Criteria for Selection of an Aerial System

The following criteria are considered as basis for selection of an aerial structure.

A. Aesthetics

B. Constructibility

C. Economics of the structure

D. Maximization of competition for construction

E. Single shape for full length of alignment

F. Minimum transitions

G. Ease of hauling material, precast girders, and/or girder segments

H. Ease of maintenance

I. Minimum distraction to highway traffic and the surrounding community

J. Minimum construction easement requirement

K. Local availability of material.

4.3 Preliminary Studies

A. We have considered several guideway girder configurations using different construction materials, which include steel, precast concrete, poured-in-place concrete, and combinations thereof. The typical sections of guideway girder and piers considered are enclosed as Appendix A, Figures 1 through 23. Feasibility of these sections for the candidate alignment is discussed in Paragraph 4.5 of this report.

B. Appendix B includes typical sections of the guideways constructed in Atlanta, Baltimore, Miami, San Francisco, and Washington, D.C. We have considered the merits of each system and tried to implement them for the proposed aerial structure. Feasibility of these systems to the candidate alignment is discussed in Paragraph 4.6 of this report.

C. Appendix C includes a three-span continuous structure designed by the California State Department of Transportation for a light rail transit structure at the airport viaduct portion (part of Century Freeway project). This project is discussed in Paragraph 4.7 of this report.

D. Appendix D includes a typical aerial guideway configuration, a typical support system at an aerial station, and a typical pier at an aerial station.

E. Appendix E includes a plan and profile of candidate alignment J8 J/A3.

4.4 Purpose of Preliminary Studies

A. Determining an aesthetically-appealing aerial structure that will enhance the architecture of existing urban environments along Vermont Avenue

B. Determining structure feasibility

C. Constructibility: Selecting a structure that can be constructed by different construction techniques

D. Economics

1. Determining the most cost-effective guideway girders which can satisfy the above three requirements

2. Determining an economical span length

3. Determining a cost-effective substructure that is suitable for the proposed superstructure and subsurface geology of Vermont Avenue, and that can meet seismic requirements.

4.5 General Evaluation of the Aerial Guideway Configuration

Please refer to Appendix A, Figures 1 through 18.

A. Figure 1: Typical box guideway box girders.

1. The rectangular form (a) is a precast post-tension girder measuring 5 feet, 0 inchs deep by 13 feet, 1 inch wide by 110 feet long. It was used in the Miami heavy rail system.

2. The same girder can be designed with sloping webs, using trapizoidal forms (b).

3. The girder can also be designed using inside pipe arch forms (c).

Single-girder supporting single track is not proposed for the candidate alignment for the following considerations:

A. Aesthetic appeal is lacking.

B. A cap beam over a single column will be required to support two girders.

B. Figure 2: Precast prestressed concrete double-tee guideway girder-single girder supporting a single track.

The use of this type of guideway girder is not proposed for the candidate alignment for the following considerations:

1. It is not an asthetically appealing structure which blends with the existing urban environment.

2. A hammer head (T)-type pier will be required to support two girders, and this will consequently increase the height of the guideway.

3. If pier cap and girder are of the same depth (flush bottom) both ends of the girder will need to be dapped and supported on a corbal (ledge) of the pier cap. (See Figure 19, Appendix A, for the pier cap). Dapped-end girders and pier caps with ledges have a number of serious construction problems associated with them. These problems were experienced during construction of the Miami heavy rail system.

4. The interface detail design between the column and the pier cap is a serious design/construction problem.

5. Because of their limited width and depth, it is difficult to make proper connection of girder to pier cap ledge to meet seismic requirements.

C. <u>Figure 3</u>: Two precast, prestressed concrete AASHTO girders supporting a single track with composite cast-in-place concrete deck and diaphragm.

The use of this type of construction is not proposed for the candidate alignment for essentially the same reasons as given for the Figure 2 configuration. In addition, these types of girders cannot be dapped at the ends.

D. <u>Figure 4</u>: Structural steel plate girders with composite cast-in-place concrete deck. There are plate girders for each track with a steel diaphram.

The use of this type of construction is not proposed for the candidate alignment for all the reasons given for the Figure 2 configuration. In addition, we consider maintenance of the steel structure could be a long-term, expensive commitment.

E. <u>Figure 5</u>: Structural steel box girder with composite cast-in-place concrete deck. A single box girder would support single track.

The use of this type of construction is not proposed for the candidate alignment for all the reasons given for the Figure 4 configuration:

F. <u>Figure 6</u>: Single-cell steel box girder supporting two tracks with composite cast-in-place deck.

The use of this type of guideway girder configuration is not proposed for the candidate alignment for the following considerations:

1. Lack of aesthetic appeal.

2. The maintenance required for a steel structure.

3. Limitation of the competition to the steel industry.

4. Use of the single box girder shape will not be economical for the entire system length.

5. Creation of more transition in superstructure from one depth of structure to other.

6. No study has been made as to local availability of the material and fabrication facilities.

G. Figure 7: Please refer to description of Figure 17, ahead.

H. Figure 8: Multicell concrete box girder supporting a double track.

The use of this type of guideway girder configuration is not proposed for the candidate alignment for the following considerations:

1. It does not have the aesthetic appeal to blend with the existing urban environments.

2. It would cost more than the proposed structure.

3. It will eliminate use of precast concrete, and therefore limit competition.

4. Construction will have a significant impact on traffic during installation of form work and pumping of concrete.

I. Figure 9: Dual precast prestressed concrete box girders supporting two tracks with cast-in-place concrete composite deck and diaphrams.

The use of this type of guideway configuration is not proposed for the candidate alignment for the same reasons as given for the Figure 2 configuration.

J. Figure 10: Four precast prestressed AASHTO girders supporting two tracks, with cast-in-place concrete composite deck and diaphram.

The use of this type of guideway configuration is not proposed for the candidate alignment for the same reasons as given for the Figure 2 configuration. In addition, these types of girders cannot be dapped at the ends.

K. <u>Figure 11</u>: Framing alternates. Techniques for framing are essentially dependent on the guideway configuration, type of material proposed for construction, and method of construction, such as precast concrete or cast-in-place concrete. Rigid frames with hinges are commonly used by California State Department of Transportation.

At this stage of our study, we have not investigated framing techniques. Further engineering studies are required to arrive at an acceptable technique.

L. <u>Figure 12</u>: Pier configuration a single rectangular column supporting a single girder for two tracks.

This type of pier configuration eliminates the use of a pier cap. It is economical compared to a single-column pier with a pier cap.

The use of this type of pier configuration is not proposed for the candidate alignment for the following considerations:

1. Lack of aesthetic appeal.
2. Elimination of use of single cast-in-drilled-hole concrete pile (CIDH) foundation.
3. Normal support for this type of pier would be on a minimum of two or four CIDH concrete pile foundations with a pile cap, or conventional driven piles and pile cap.

M. <u>Figure 13</u>: Pier configuration: A single column with a cap beam supporting two guideway girders. One girder supports one track.

Please refer to the description of Figure 16, further on.

N. <u>Figure 14</u>: Pier configuration: Double column with cap beam supporting two-track structure. This type of substructure can be proposed for the guideway configuration defined in Figures 3, 4, and 10.

The use of this type of substructure is not proposed for the candidate alignment for the following considerations:

1. Lack of aesthetic appeal.
2. A two-column pier cannot be accommodated in the middle of Vermont Avenue.

3. Use of the pier cap will increase the height of the guideway profile.

O. Figure 15: Pier configuration: A two-column pier with no cap beam, each column supporting a single guideway girder and one track.

The use of this type of substructure is not proposed for the candidate alignment for the following considerations:

1. Lack of aesthetic appeal.

2. A two-column pier cannot be accommodated in the middle of Vermont Avenue.

P. Figure 16

1. Superstructure (aerial guideway girder): A single girder supporting one track.

Girders are 5 feet, 0 inches deep by 13 feet, 0 inches wide with vertical webs, and 110 feet long, precast in the precasting yard and post-tensioned. Each girder is transported as one unit by trucks on site and installed on the cast-in-place concrete piers with the help of two cranes. It is estimated that a contractor can install from approximately 4 to 6 girders per day.

2. Substructure

a. Cap Beam: Cast-in-place concrete cap beam would have a blockout for the beam seat. Supported girder ends will not be dapped and there would be no ledges associated with the cap beam. The cap beam would be of conventional reinforced concrete.

b. Column: A cast-in-place concrete column is rectangular in section with ten inch chamffers on all four corners. Width of the column would be from approximately 4 feet, 6 inches to 5 feet, 0 inches.

c. Foundation: The foundation can be either conventional pile footing or CIDH hole concrete pile.

We have not proposed this guideway configuration for the candidate alignment for essentially aesthetic reasons. Also, we have not studied the availability in the close vicinity of the proposed site of precasting yards, hauling routes, and transportation facilities to transport 110-foot long girders in one piece. Further engineering studies are required to establish a clear cost for comparison with the proposed configuration to determine acceptability.

Q. Figure 17

1. Superstructure (aerial guideway): A single girder supporting two tracks.

   This structure can be constructed using several different construction techniques, all of which are discussed for the proposed aerial structure further on in Paragraph 4.7 of this study.

2. Substructure

   a. Column: Guideway girder is directly supported on a single column with a column capital, which is rectangular in section. Width of the column would be 5 feet, 0 inches. Column up to 10 feet above the finished roadway would have constant section of 5 feet, 0 inches, 7 feet, 0 inches with 10-inch chamffers at all four corners. Column section would vary from 9'-0" x 5'-0" at top to 7'-0" x 5'-0" at 10 feet above finish roadway elevation.

3. Foundation: Can be either conventional pile footing or CIDH concrete pile.

   We have not proposed this guideway configuration for the candidate alignment for essentially aesthetic reasons.

R. Figure 18: A single girder supporting two tracks, the girder supported on a single-column pier.

   This structure is that proposed for the candidate alignment. It meets the description provided in the responses to comments and questions from the First Core Forum, published by the Southern California Rapid Transit District in November, 1986. A detailed description of this structure is provided in Paragraph 4.7 of this report, and drawings are attached as Appendix D.

4.6 General Evaluation of the Aerial Guideways Constructed in Other Cities of the U.S.A.

Please refer to Appendix B, Figures 1 through 10.

A. Figure 1: MARTA Aerial Structure. Single precast segmental concrete girder and deck for two tracks, post-tensioned, supported on a single rectangular column.

Refer to the description of Figure 17, Appendix A, Paragraph 4.5-Q of this report.

B. Figure 2: MARTA Aerial Structure. Cast-in-place monolithic concrete single box girder and deck for two tracks, post-tensioned, supported on a single rectangular column.

The use of this guideway configuration is not proposed for the candidate alignment for the following considerations:

1. The structures do not have the aesthetic appeal to blend with existing urban environments.

2. The structures would cost more than the proposed structure.

3. They will eliminate the use of precast concrete girders and therefore limit competition.

4. They will create significant impact to traffic during formwork installation and concrete pumping.

C. Figure 3: MARTA Aerial Structure, Steel Girder Option. Precast concrete deck slab is approximately 28 feet wide with two tracks supported by a single steel box girder. The steel box girder is supported on a single rectangular cast-in-place concrete column.

The use of this type of aerial guideway configuration is not proposed for the candidate alignment for the following considerations:

1. Lack of aesthetic appeal.

2. Cost is more than the proposed structure.

3. Difficulty of designing adequate connection for the precast deck and steel box girder for seismic requirements.

4. Maintenance of steel structure is a long term expensive commitment.

D. Figure 4: MARTA Aerial Structure. Single precast pre-stressed concrete box girder supporting single track on a single column.

This type of structure configuration is not suited for the candidate alignment. It is generally used for a guideway with a center platform station.

E. Figure 5: Baltimore Aerial Structure. Two precast prestressed concrete box girders are supported on cast-in-place concrete pier cap and single column. One box girder supports one track.

Refer to the description of Figure 16, in Appendix A, Paragraph 4.5 P of this report.

This structure is similar to the one proposed in Figure 16 except that the girders shown in Figure 16 rest on the pier cap in horizontal position. Superelevation is accounted in the adjustment of the rail pad height.

F. Figure 6: Miami Aerial Structure - Spans Over 80 Feet. Two precast prestressed (post-tensioned) concrete box girders 5 feet, 0 inches deep by from 12 feet, 0 inches to 13 feet, 1 inch wide with a maximum length of 110 feet with dapped ends, supported on the ledge of the cast-in-place concrete post-tensioned pier caps on a single column.

Refer to the description of Figures 2, 13, and 16, Appendix A in Paragraph 4.5 B, 4.5 M, and 4.5 P of this report.

G. Figure 7: Miami Aerial Structure - Spans up to 80 Feet. Two precast prestressed (pre-tensioned) concrete double tee girders 5 feet - 0 inches deep by from 12 feet - 0 inches to 13 feet - 1 inch wide with a span ranging from 40 to 80 feet with dapped ends, supported on the ledge of the cast-in-place concrete post-tensioned pier cap on a single column.

This aerial guideway configuration is not proposed for the candidate alignment for all the reasons described in Figure 2, Appendix A, Paragraph 4.5 B of this report.

H. Figure 8: Miami Aerial Structure Spans up to 80 Feet. Two precast prestressed (pre-tensioned) concrete double-tee girders of the same dimension defined for Figure 7, with a full-depth end diaphragm supported on an individual column with a common foundation.

This type of aerial guideway configuration is not feasible to locate in the middle of Vermont Avenue. Therefore it is not proposed for the candidate alignment.

I. Figure 9: BART Aerial Structure. Two precast prestressed concrete box girders supported on a cast-in-place concrete pier cap and single column.

This structure is similar to the one defined in Figure 16 Appendix A. For a description, refer to Paragraph 4.5.P of this report.

J. Figure 10: WAMATA Aerial Structure. Two twin-cell precast prestressed concrete box girders with a cast-in-place concrete composite deck with dapped ends, supported on the ledge of the cast-in-place concrete pier cap on a single column.

The very heavy appearance of this type of construction is not aesthetically appealing, and therefore it is not considered for the candidate alignment.

4.7 Salient Features of the Proposed Aerial Guideway Girder

The aerial alignment of the system will carry two tracks on a single concrete box girder, which will be erected on a single reinforced concrete column.

The box section with vertical and circular webs has an out-to-out width of 28 feet, 0 inches and a constant depth of 7 feet, 0 inches (see Figure 18). The use of a combination of vertical and circular webs will provide a reduction in both torsional stress and cantilever deflection. The girder spans would range from 75 to 130 feet, with a typical span of 110 feet along most of the alignment. The concrete box girder will be either of the following:

A. Precast Concrete Segmental Construction

1. Precast Concrete Segmental Construction (Span by Span)

Although a study of yard location and transportation of precast girders have not been made, it is feasible to precast and transport approximately 10- to 12-feet long sections of the precast box girder segments to the site, and erect the segments on reinforced concrete columns span by span. The span-by-span method can use two erection trusses, which will provide the flexibility required for varying span lengths. The two erection trusses can be supported on preliminary supports made up of steel pipe and wide flange sections. The preliminary supports would rest on the pier foundation or trusses could be placed directly on the framed piers. The segments of one span are positioned on the trusses by a crane located on the ground in front of the trusses.

After all segments for a span are in place, the longitudinal post-tensioning is stressed and grouted. The trusses are lowered, temporary supports are adjusted in the next span, and the trusses are then advanced and positioned in the next span. (See Figures 22 and 23).

2. Precast Concrete Segmental Construction (Segment By Segment, Successively Post-tensioned)

As an alternative to the span-by-span construction technique, precast segments could be erected by use of traveling gantry cranes placed over the pier segment. Gantry cranes would pick up the segment from the truck and hold it against either the pier segment or the last segment erected. Longitudinal prestressing cables would be spliced with the cables of the adjacent segment. After the alignment and shear keys are properly engaged, longitudinal post-tensioning would be stressed. Epoxy will be used to join the segments. Thus, each segment is be erected and successively post-tensioned. Temporary supports may be used to provide support for segments and to reduce cantilever moment. (See Figure 20, Appendix A).

B. Cast-In-Place Concrete

1. The proposed guideway box girder section, with vertical and circular webs of the same dimension used for pre-cast concrete segments, can be constructed using conventional techniques of cast-in-place concrete and false work. There are five different framing methods that can be utilized to accomplish this task. (See Figure 11).

   a. A three-span continuous structure.

   b. Simple spans, with full depth ends.

   c. A three-span continuous structure with center-suspended span.

   d. A three-span continuous structure with two interior supports made integral with the super structure.

   e. A three-span continuous structure with all four supports integral with the superstructure; hinge supports would be located from about 15 to 20 feet away from the rigid frame structure. This type of framing technique is very commonly used by California State Department of Transportation. A similar framing technique is proposed to support the light rail transit structure at the airport viaduct portion of Century Freeway Project. Plans for this project are attached to this report as Appendix C.

2. Cast-In-Place Construction, Span By Span

We propose to use a three-span continuous structure for cast-in-place concrete constuction. Three-continuous-span construction would be achieved by using a minimum of two intermediate supporting towers between the abutment and the pier to support the false work. False work would be extended from approximately 15 to 20 feet from the pier. Reinforcement and prestressing cable would be laid, and concrete would be placed by pumping. After the concrete attains specified initial strength, longitudinal post-tensioning would be stressed and forms would be striped. Striped forms are then positioned in the next span by suspending them from the cantilever structure and using one supporting tower positioned from approximately 15 to 20 feet on each side of the next pier. Thus the concreting and post-tensioning procedure would be repeated. (See Figure 21, Appendix 'A').

3. Cast-In-Place Construction, Three Span Structure

Alternatively, falsework could be erected for the full three span lengths of structure. After the concrete attains specified initial strength, longitudinal post-tensioning would be stressed from both ends of the structure and grouted.

4. Cast-In-Place Concrete Segmental Construction

A box girder segment approximately 30 feet long segment is first constructed integral with the pier, using fixed forms. Two travelling forms (one on each side of the pier) are fastened to the pier segment. After the concrete attains specified initial strength, longitudinal post-tensioning would be stressed. Forms would advance over the constructed segment and be positioned for the next one. Thus, match castng and successive post-tensioning would complete the aerial structure. This technique of construction does not require temporary support and is the least disruptive to traffic.

C. Substructure

The reinforced concrete round column (pier) to support the box girder will be approximately 7 feet in diameter. (See drawing attached as Appendix D to this report.) The height of the pier will be set to provide a minimum vertical clearance of 16 feet, 6 inches to the underside of the girder at all locations.

D. Foundation

The pier foundation would consist of either piles or CIDH concrete piles. The type and number of piles and the size of the pile cap will depend on the span length, projected loads, and existing subsurface geological conditions of the site.

4.8 Construction Sequence

The typical construction sequence for an aerial guideway system would normally involve the following phases:

A. Clearing median and relocating existing utilities (if any)

B. Pile driving/installation at pier location

C. Installation of pile cap

D. Column construction

E. Guideway construction, including post-tensioning

F. Restoration and/or relocation of street.

4.9 Aerial Station Structure

The proposed alignment, coupled with existing structures and traffic patterns, dictated that all aerial stations be side platform stations. The station platform girder will be either single-unit, precast prestressed concrete box girders, or a double tee beam which will be supported by the cast-in-place reinforced concrete pier cap. These will be spaced approximately 75 feet part. Platform girders are 12 feet, 6 inches wide by 5 feet, 0 inches deep, with an additional 4 1/2 feet for finishes.

The height of the platform above the street level will vary, depending on the station location. The finished platform will be located 3 feet, 8 inches above the top of the rail elevation. The height of the finished station platform will be approximately 37 feet above street level.

Inbound and outbound platforms will be connected by a pedestrian bridge located at the center of the station. Clearance above the street at the pedestrian bridge location will be a minimum of 16 feet, 6 inches. Station entry concourse, at street level, will be equipped with fare vending machines (fare collection) for patron entry. Two elevators will provide access to both platforms for the handicapped. The vertical circulation will consist of escalators, stairs, and elevators provided for entering and exiting at each station. A separate set of escalators and stairs at each end of the bridge will be provided from the pedestrian bridge level to the platform level.

The platform length is partially covered by either lightweight precast concrete, glass, or acrylic canopy.

The traction power substation will be located beyond the street right-of-way. Special trackwork at the crossover location can be accommodated without making any visible change in guideway configuration.

4.10 Summary

A summary of three important guideway configurations is provided in the following tabulation for all the criteria defined to select an aerial guideway in Paragraph 4.2 of this report. These three guideway configurations are represented in Figures 16, 17, and 18 of Appendix A, and fourteen drawings attached as Appendix D.

4.11 Overall Evaluation

The aerial guideway configuration represented by Figure 18 is judged the best suited for the candidate alignment. Based on the Southern California Rapid Transit District committment to provide an acceptable aerial structure, consideration was given to structure aesthetics before any other criteria in our evaluation.

The figures used in the following tabulation denote:

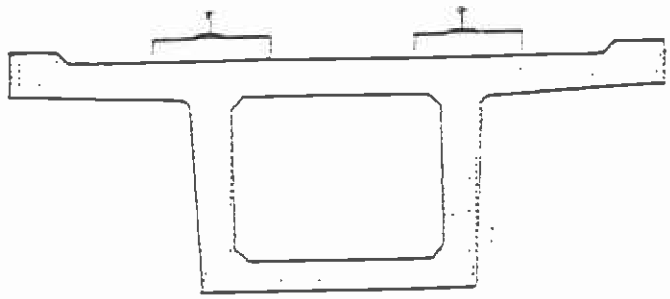
1 = Excellent
2 = Best
3 = Good
4 = Fair.

TABLE 1.
Evaluation of Aerial Guideway Configurations

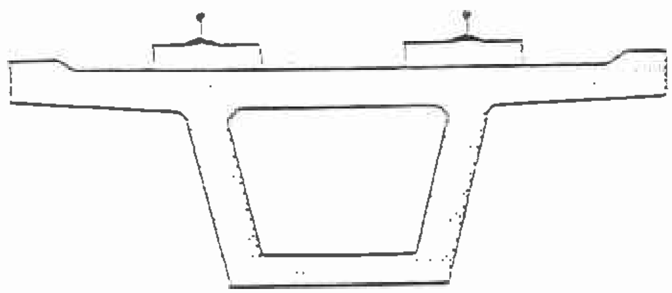
Item	Selection Criteria	Figure 18 Configuration	Figure 17 Configuration	Figure 16 Configuration
a.	Aesthetics	1	2	3
b.	Constructibility	3	2	1
c.	Economics of structure	Most expensive	Less expensive	Least expensive
d.	Maximization of competition	1	1	1
e.	Single shape for full length of alignment	2	2	1
f.	Minimum transition	2	2	1
g.	Ease of transporting	1	1	1
h.	Ease of maintenance	1	1	1
i.	Minimum disruption to highway traffic	3	3	2
j.	Construction easement requirement	3	3	2
k.	Local availability of material	17	17 Not studied	13

APPENDIX A

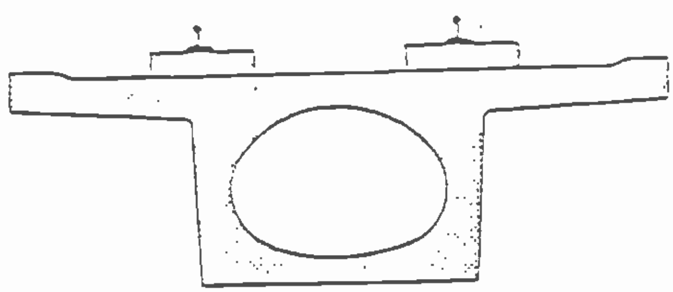
PRESTRESSED CONCRETE BOX GIRDER, SINGLE-TRACK



a. Rectangular Form



b. Trapezoidal Form



c. Pipe Arch Form

FIGURE 1

PRESTRESSED CONCRETE DOUBLE-TEE GIRDER, SINGLE-TRACK

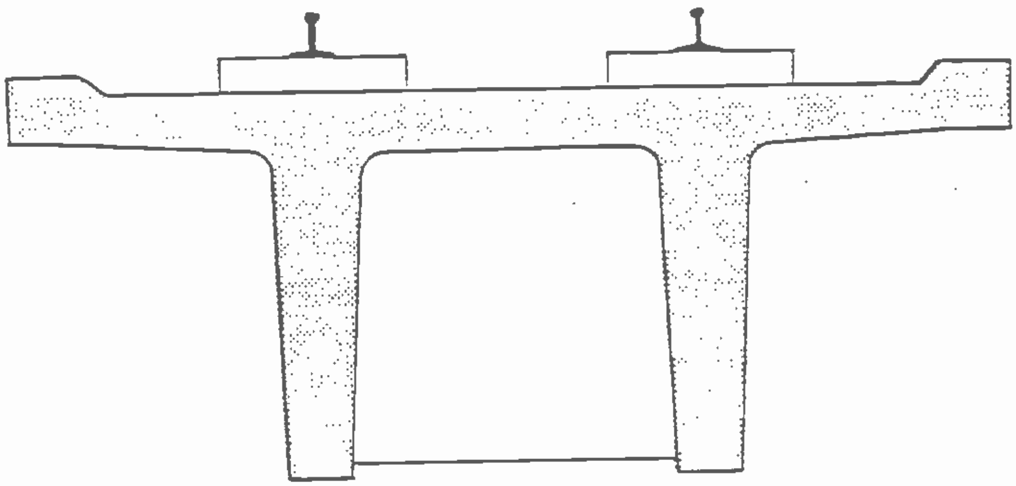


FIGURE 2

PRESTRESSED CONCRETE AASHTO GIRDERS, SINGLE-TRACK

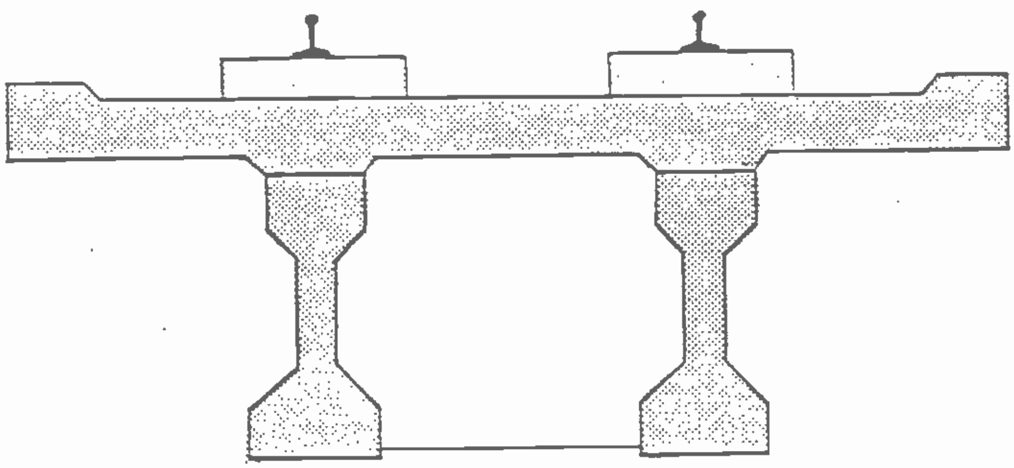


FIGURE 3

STEEL "I" BEAMS, SINGLE-TRACK

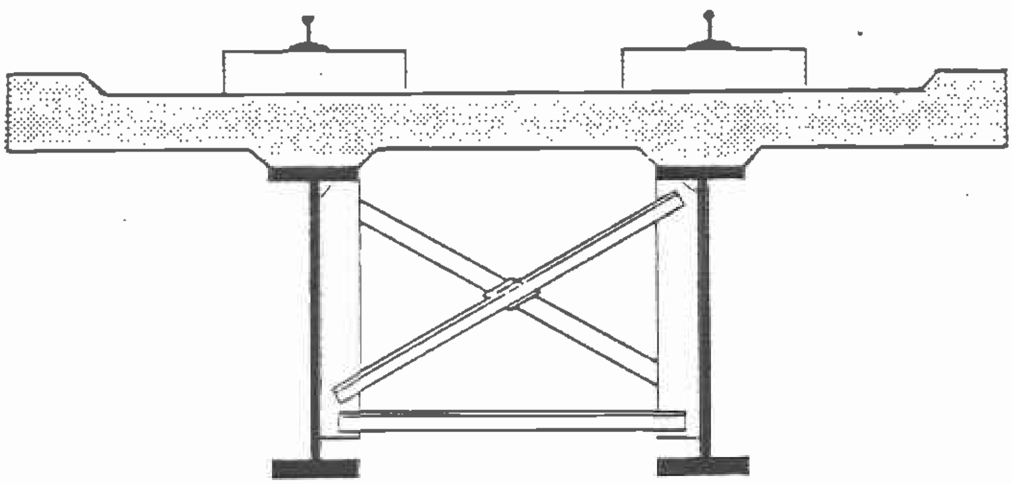


FIGURE 4

STEEL BOX GIRDER, SINGLE-TRACK

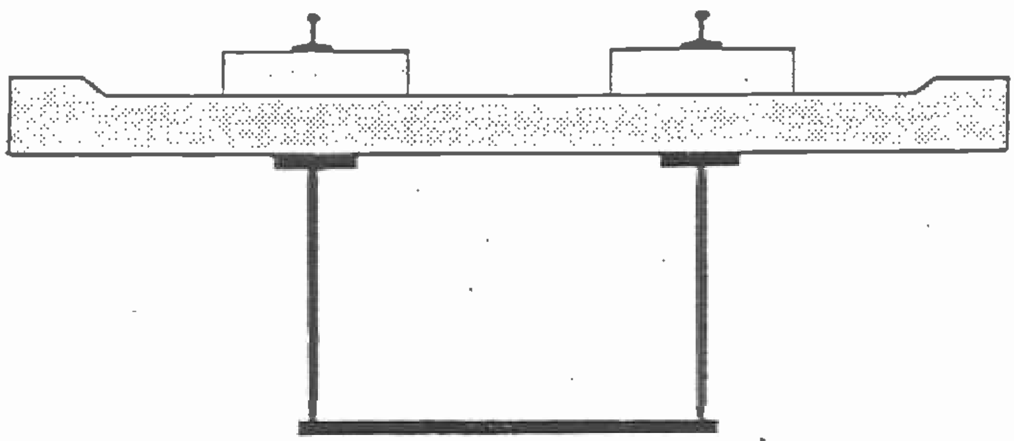


FIGURE 5

SINGLE-CELL STEEL BOX GIRDER, DOUBLE-TRACK

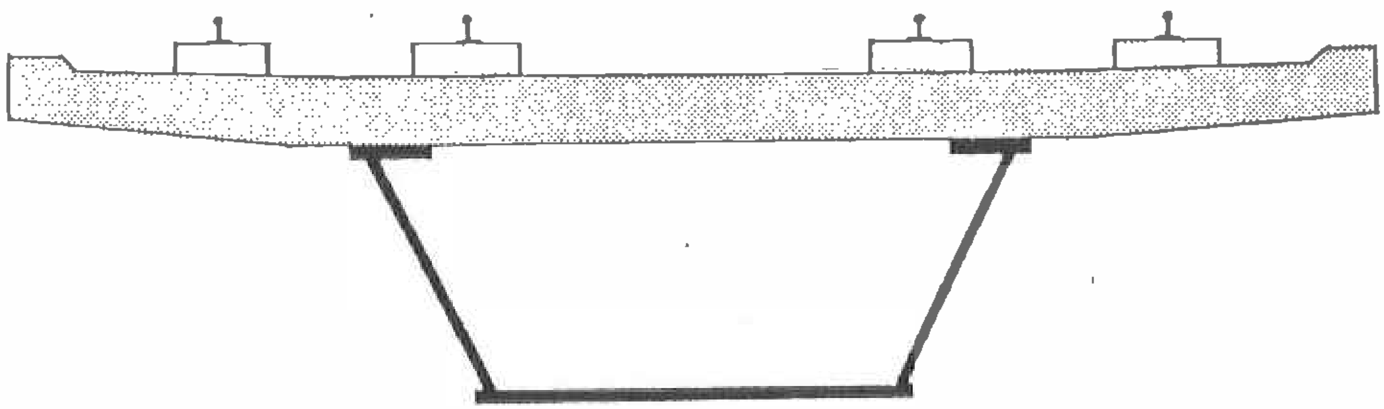


FIGURE 6

SINGLE-CELL PRESTRESSED CONCRETE BOX GIRDER, DOUBLE-TRACK

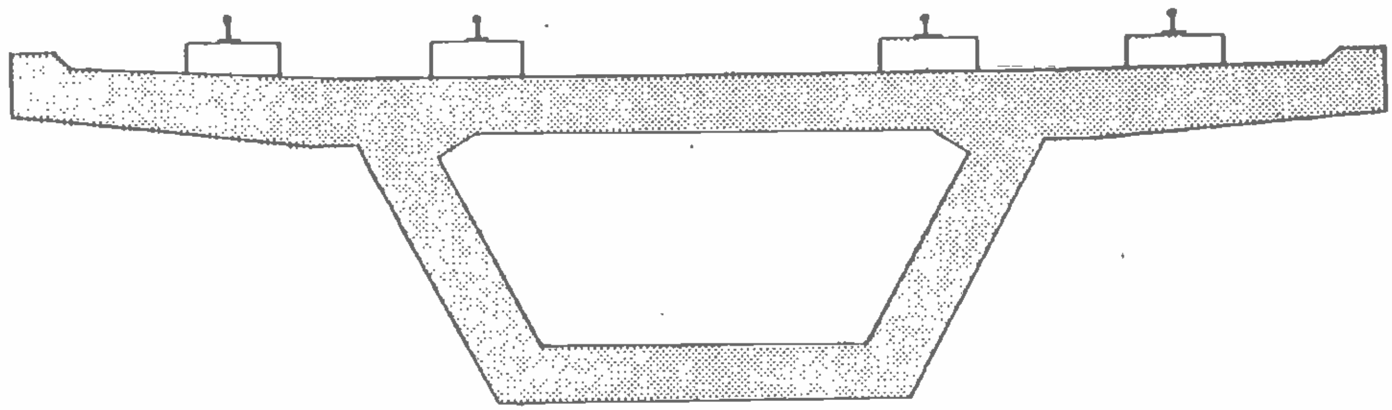


FIGURE 7

MULTICELL CONCRETE BOX GIRDER, DOUBLE-TRACK

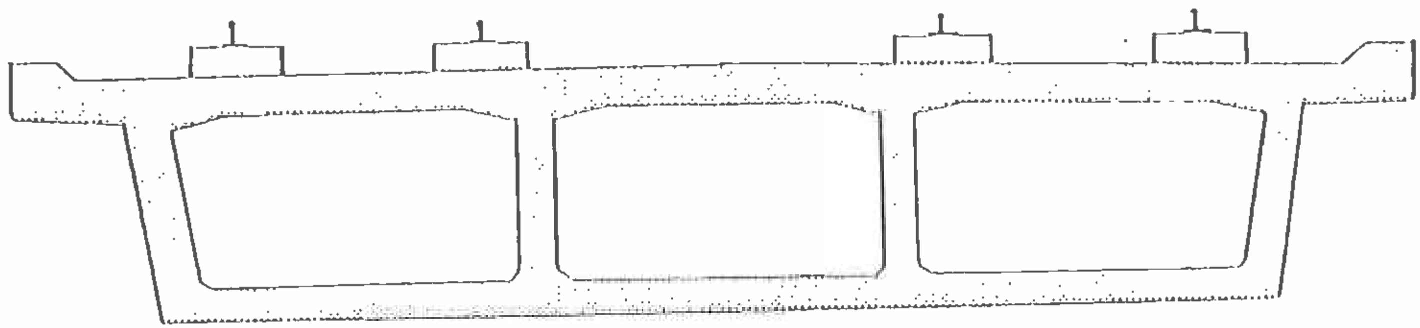


FIGURE 8

DUAL CONCRETE BOX GIRDERS, DOUBLE-TRACK

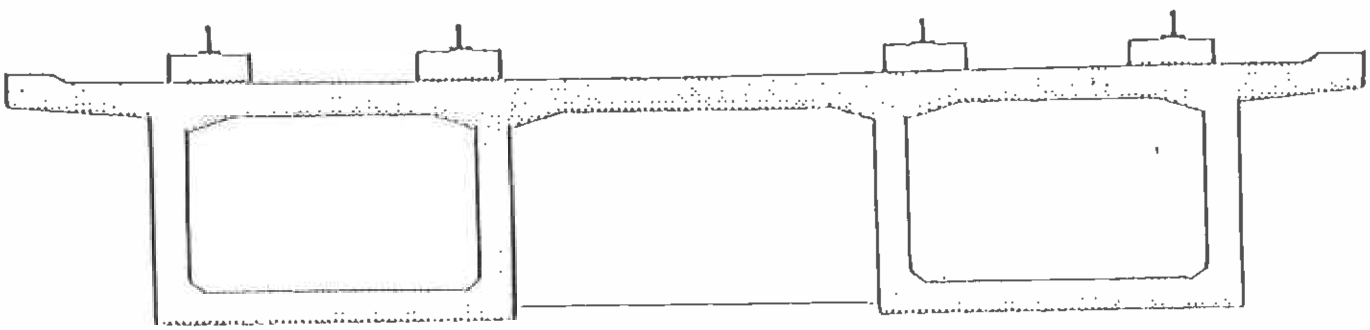


FIGURE 9

PRESTRESSED CONCRETE AASHTO GIRDERS, DOUBLE-TRACK

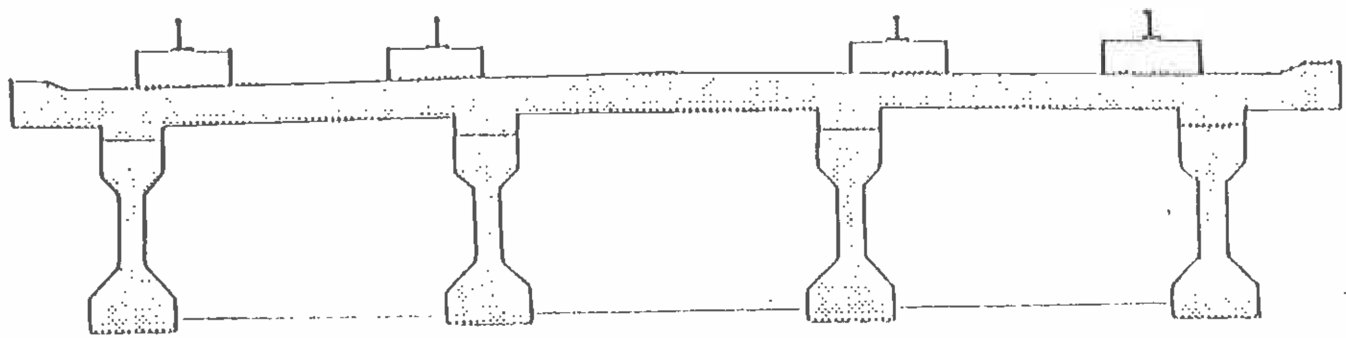
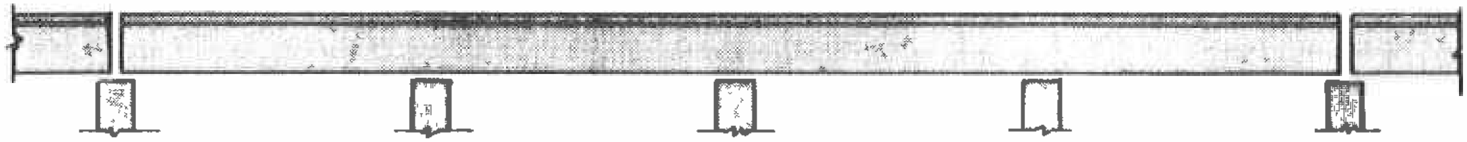
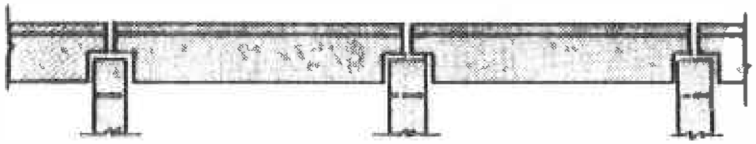


FIGURE 10

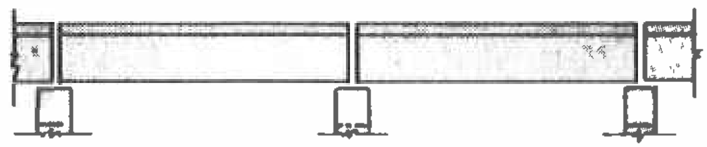
GIRDER SPAN CONTINUITY



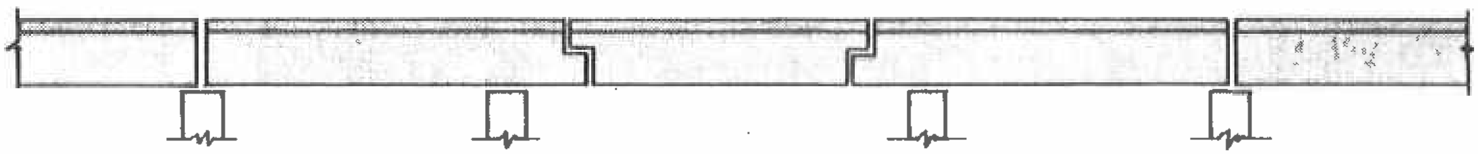
A. Continuous Spans



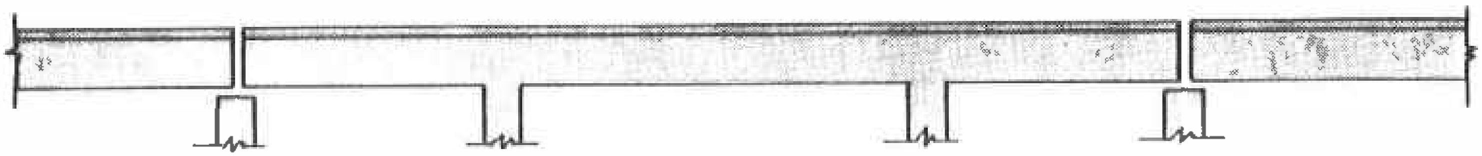
B. Simple Spans, Dapped Ends



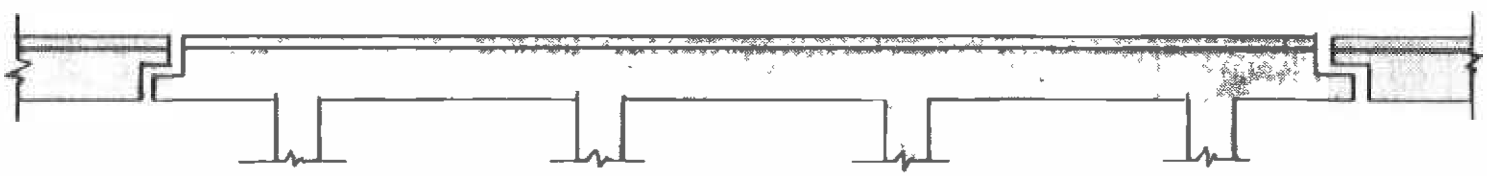
C. Simple Spans, Full-Depth Ends



D. Suspended Span



E. Rigid Frame



F. Rigid Frame with Hinges

FIGURE 11

DOUBLE-TRACK SUBSTRUCTURE WITH SINGLE COLUMN AND NO CAP BEAM

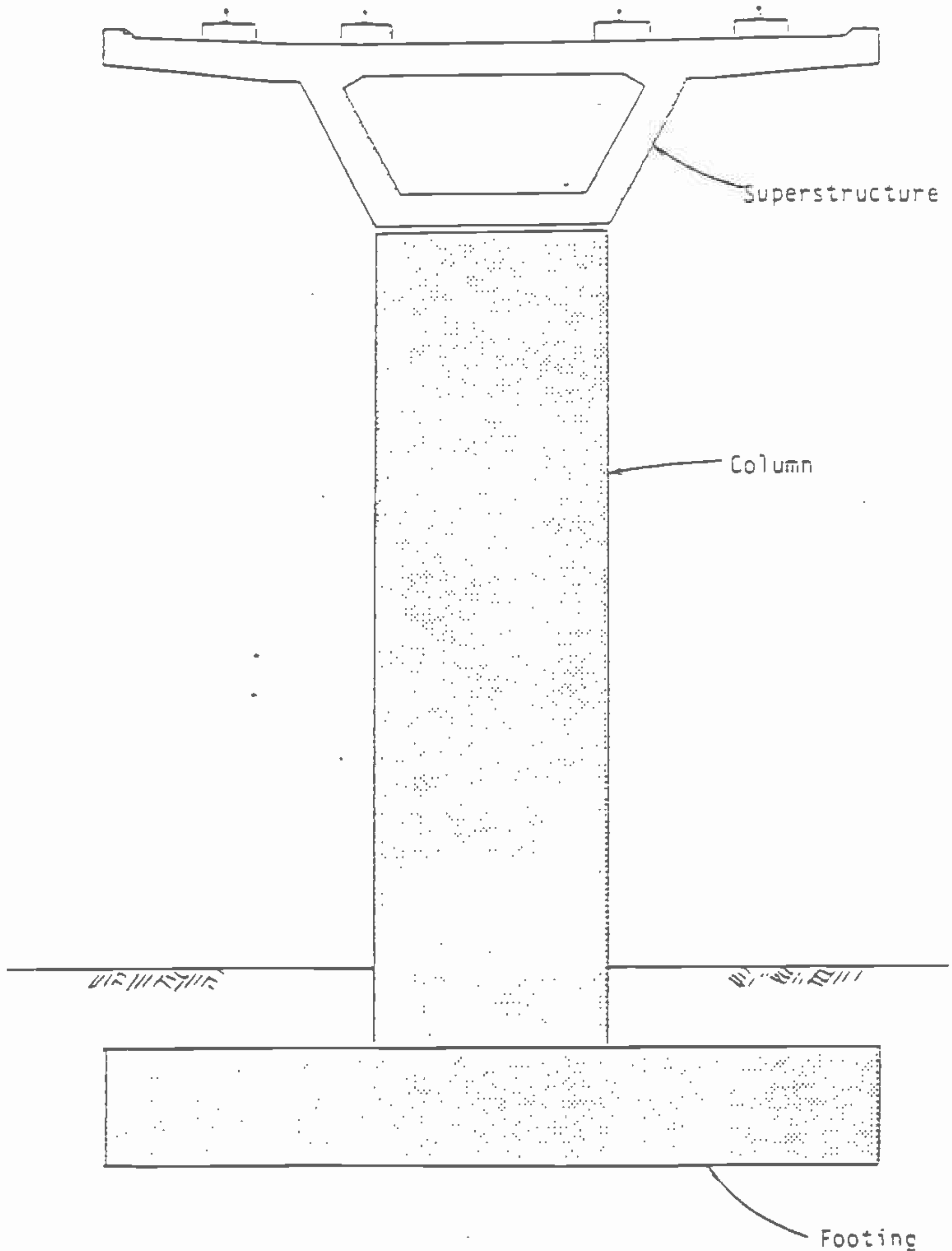


FIGURE 12

DOUBLE-TRACK SUBSTRUCTURE WITH

SINGLE COLUMN AND CAP BEAM

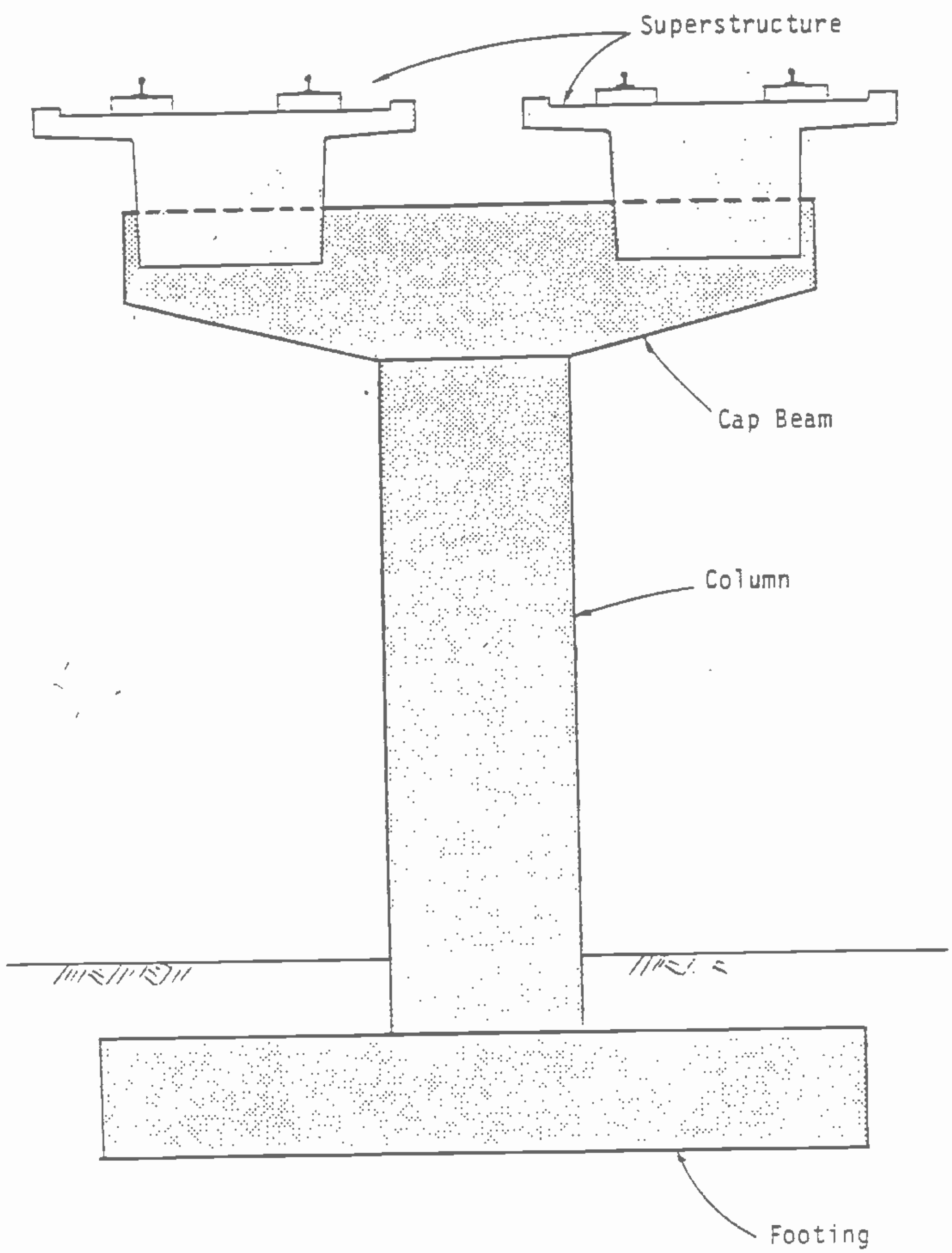


FIGURE 13

DOUBLE-TRACK SUBSTRUCTURE WITH

TWO COLUMNS AND CAP BEAM

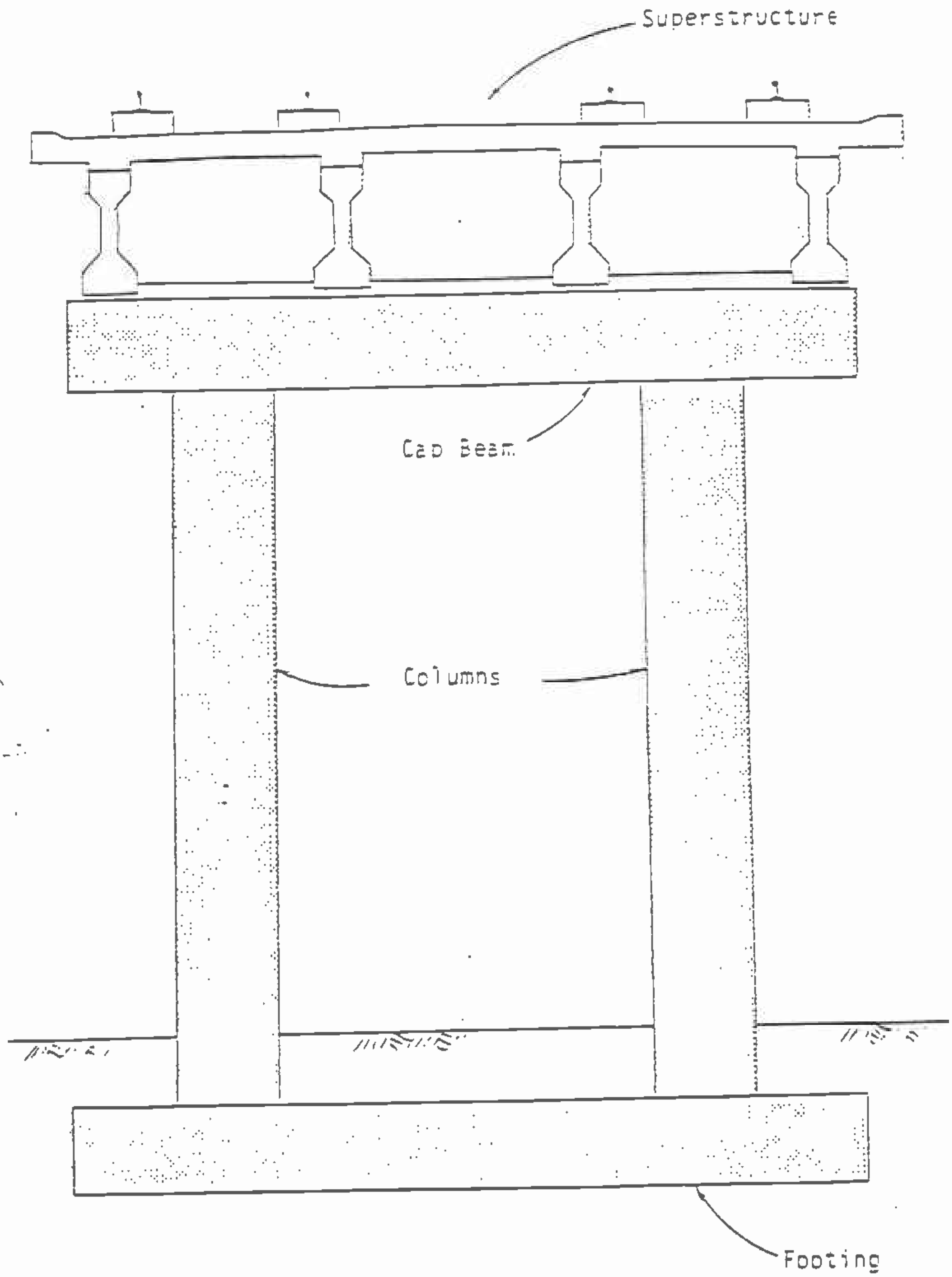


FIGURE 14

DOUBLE-TRACK SUBSTRUCTURE WITH

TWO COLUMNS AND NO CAP BEAM

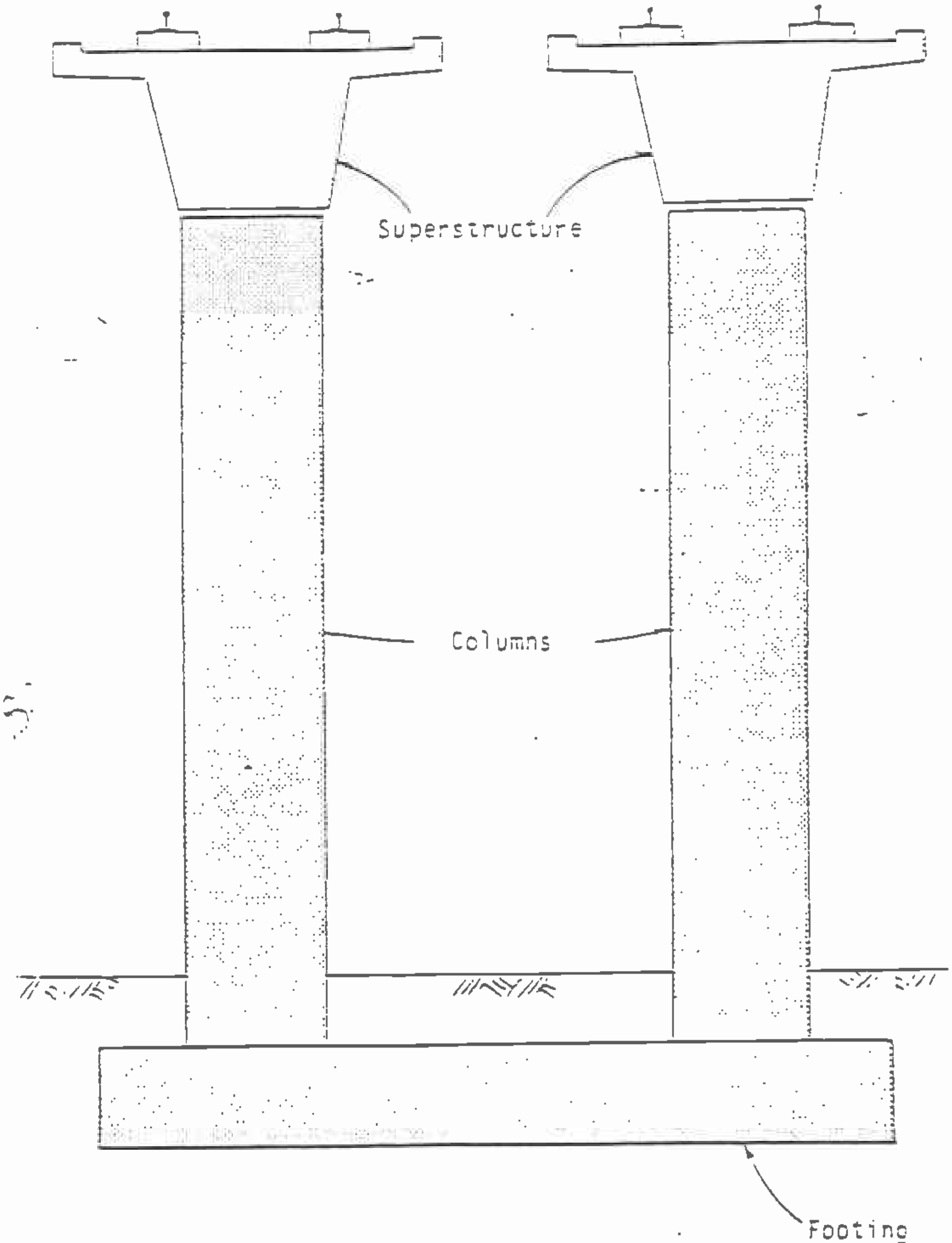
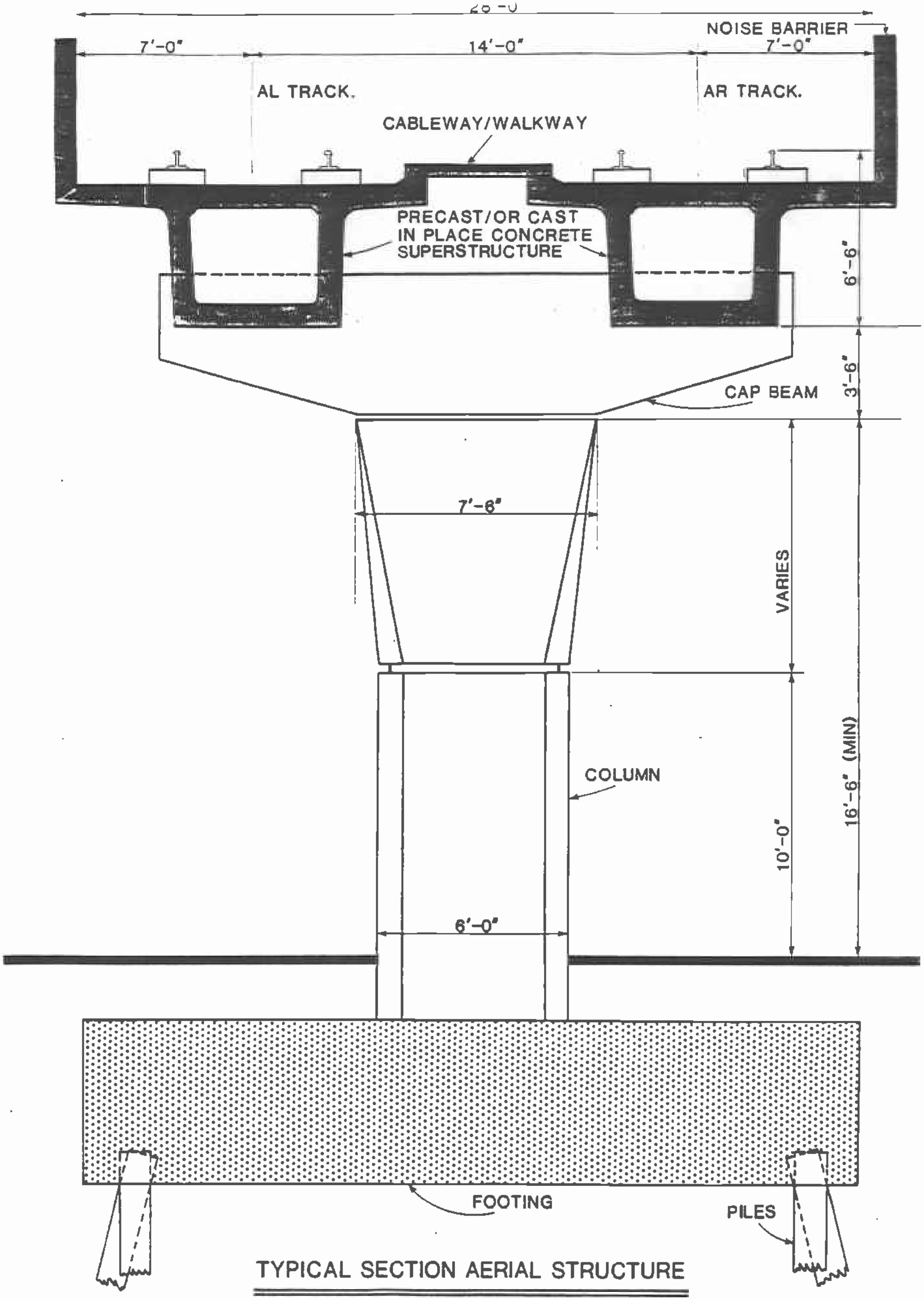


FIGURE 15



TYPICAL SECTION AERIAL STRUCTURE

Figure 16

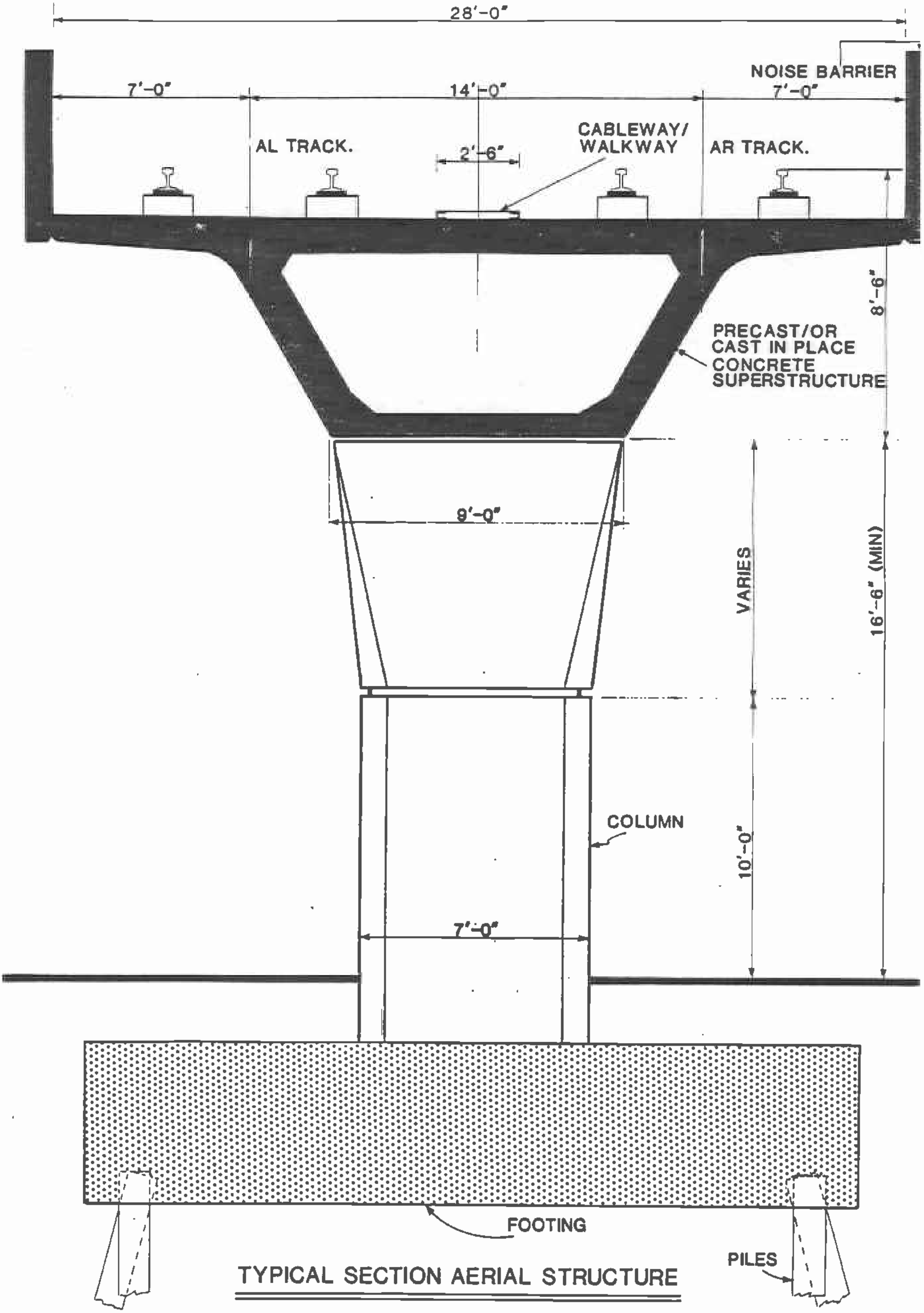
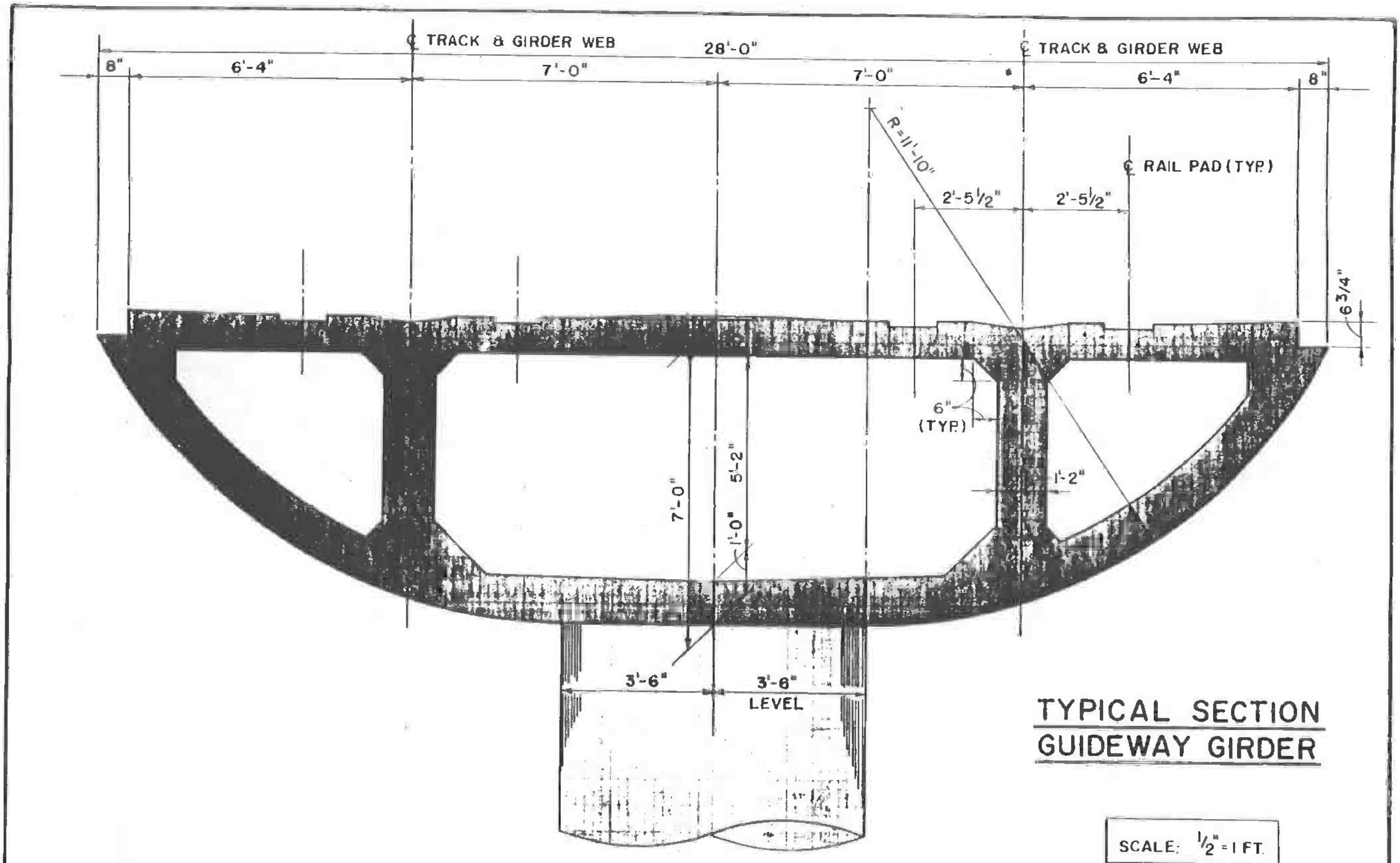

28'-0"
NOISE BARRIER
7'-0"
14'-0"
7'-0"
AL TRACK.
CABLEWAY/
WALKWAY
AR TRACK.
2'-6"
8'-6"
PRECAST/OR
CAST IN PLACE
CONCRETE
SUPERSTRUCTURE
9'-0"
VARIES
16'-6" (MIN)
COLUMN
10'-0"
7'-0"
FOOTING
PILES
TYPICAL SECTION AERIAL STRUCTURE

Figure 17



℄ TRACK & GIRDER WEB
28'-0"
℄ TRACK & GIRDER WEB
8"
6'-4"
7'-0"
7'-0"
6'-4"
8"
R=11'-10"
℄ RAIL PAD (TYP.)
2'-5½"
2'-5½"
6¾"
6" (TYP.)
1'-2"
7'-0"
5'-2"
1'-0"
3'-6"
3'-6"
LEVEL
TYPICAL SECTION
GUIDEWAY GIRDER
SCALE: ½" = 1 FT.

Figure 18

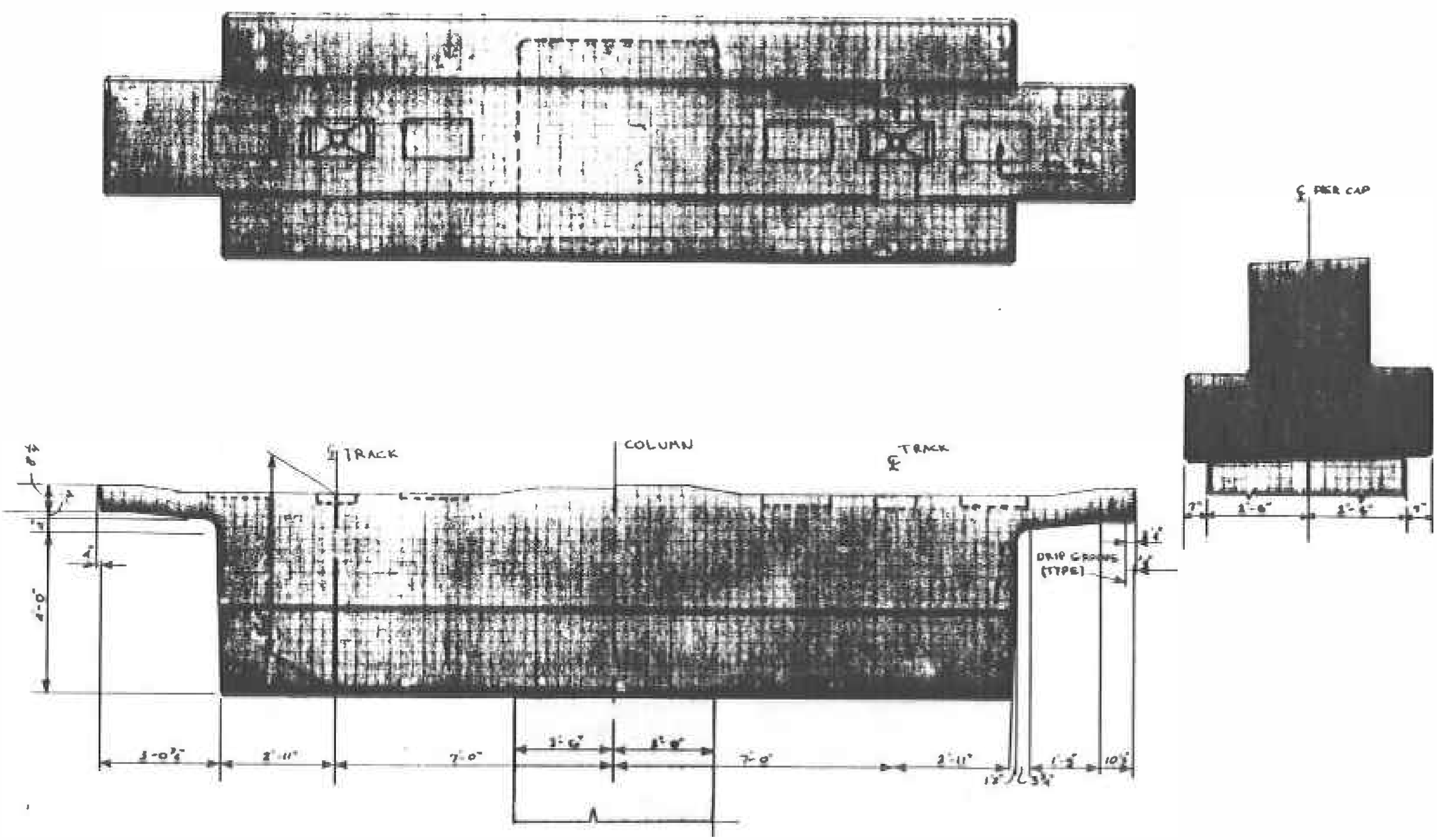
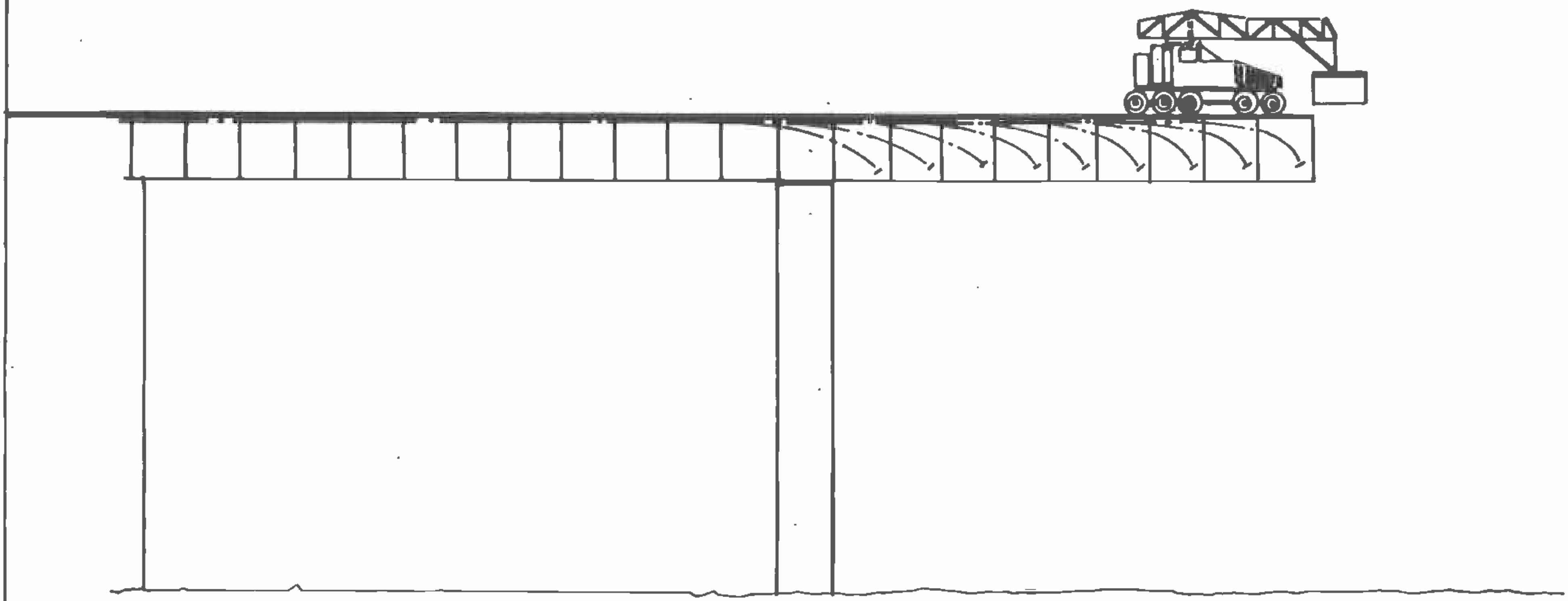
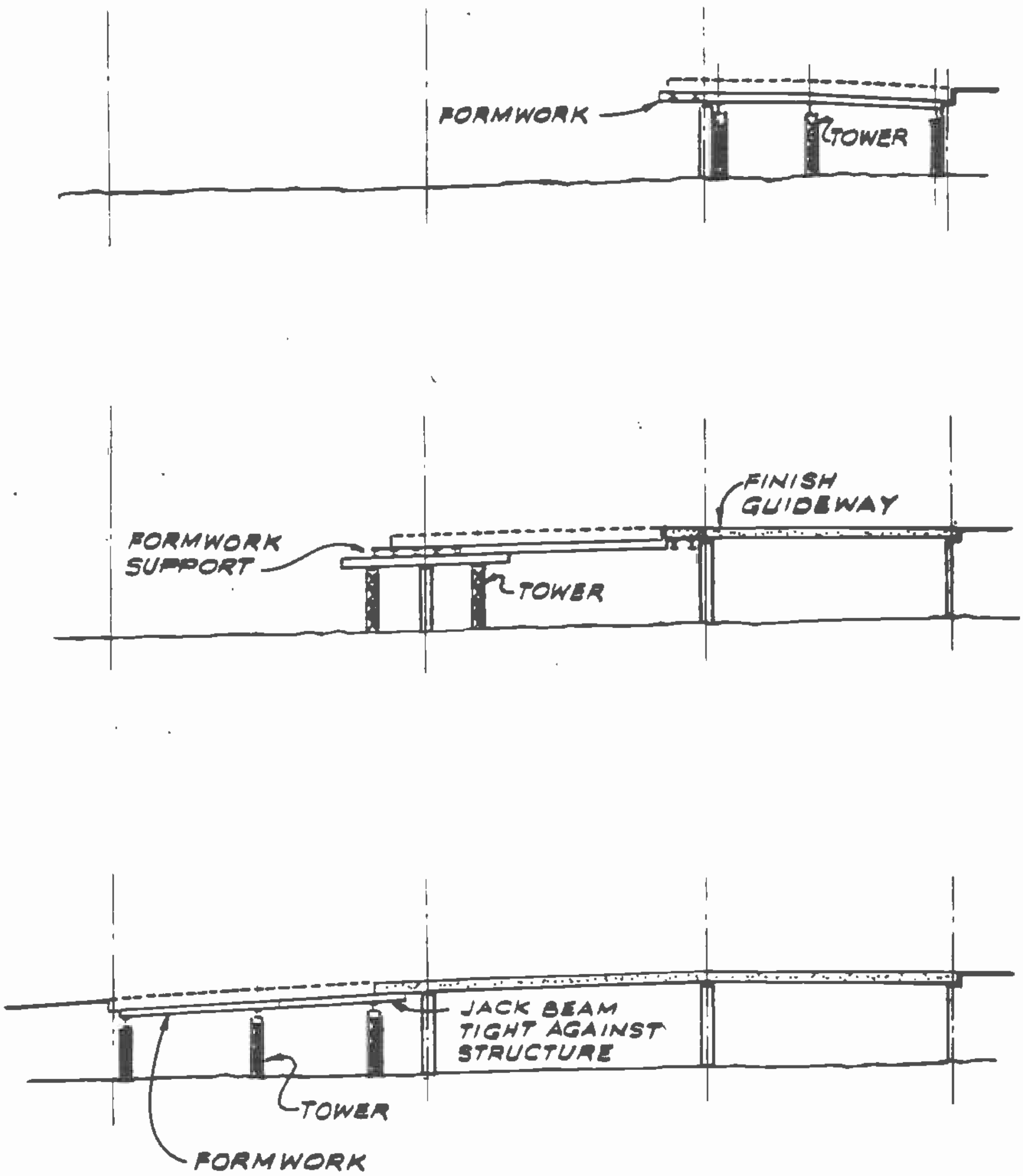


Figure 19



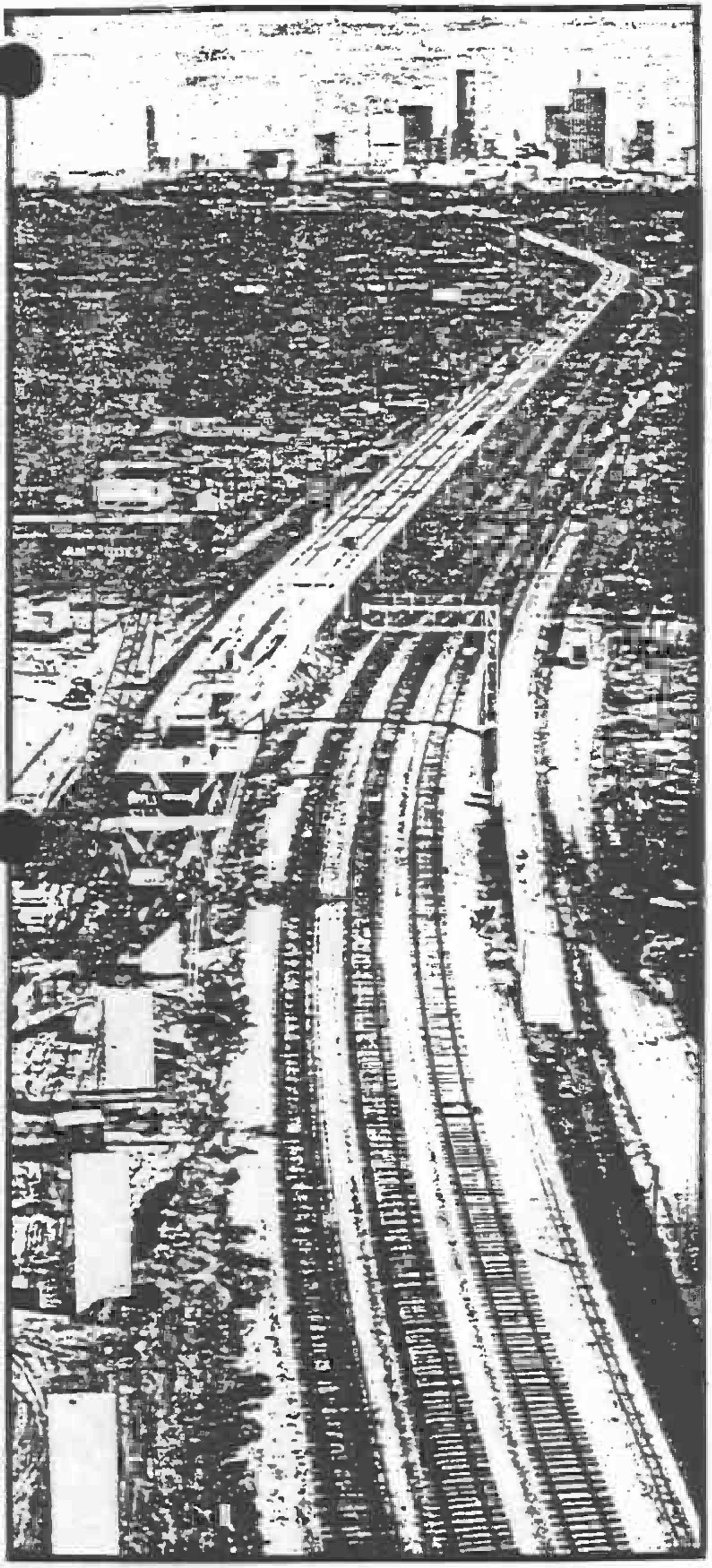
PRECAST CONCRETE SEGMENTAL CONSTRUCTION
SEGMENTS LIFTED BY MOVING GANTRY
SUCCESSIVE POST-TENSIONING

FIGURE 20

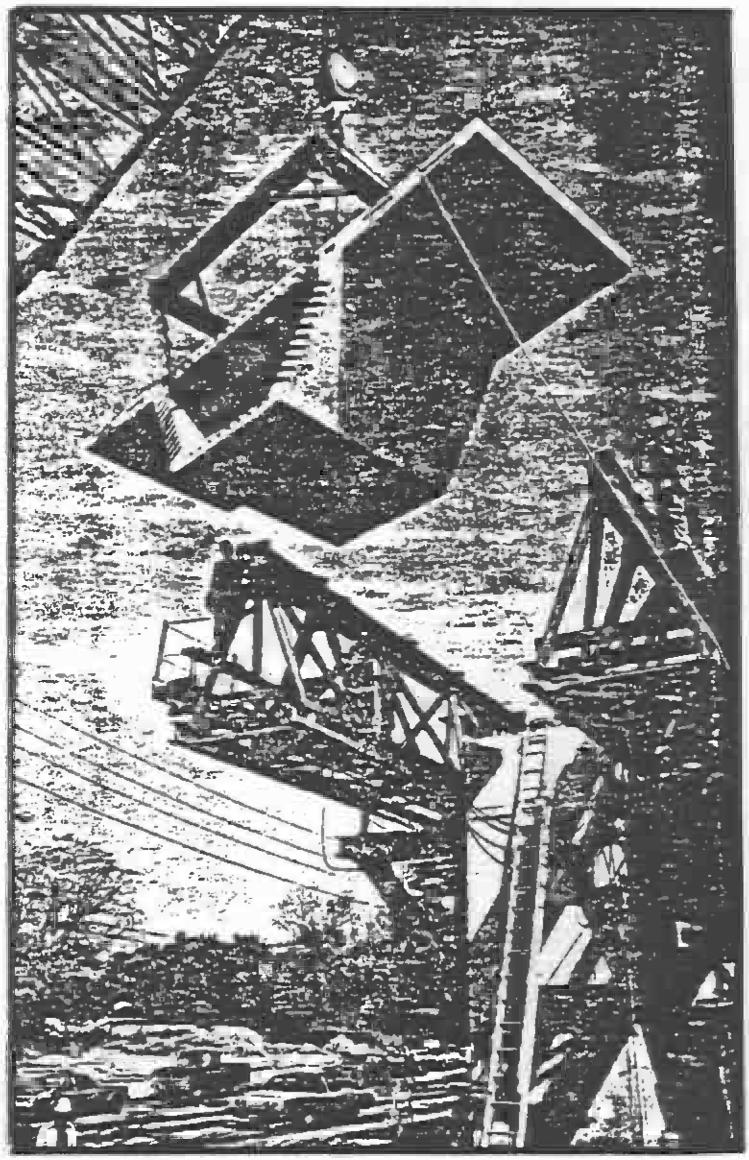


CONSTRUCTION SEQUENCE FOR
C.I.P. CONCRETE AERIAL GUIDEWAY
SPAN BY SPAN CONSTRUCTION

FIGURE 21

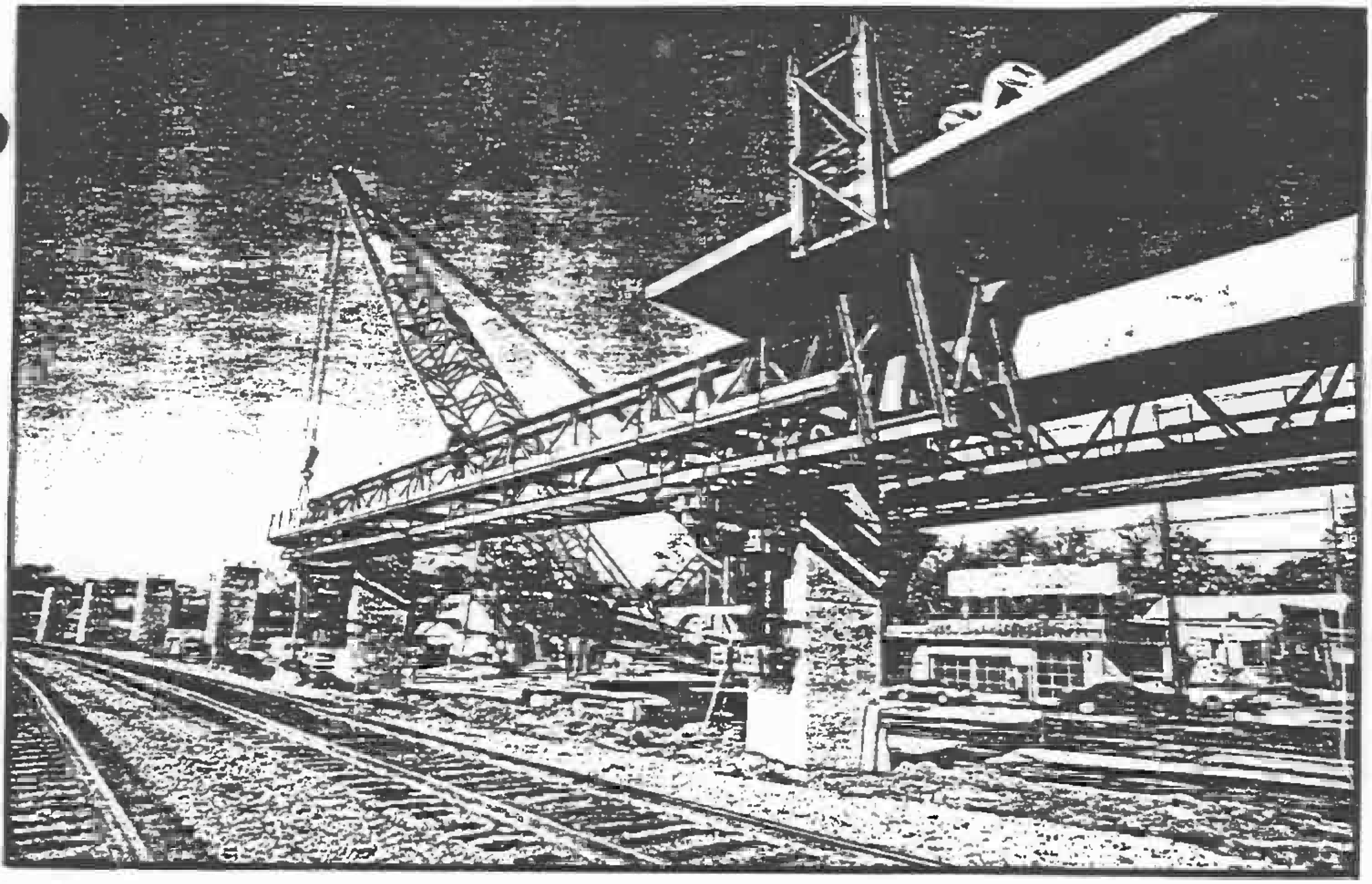


Elevated transit structure proceeds at rate of up to four spans a week

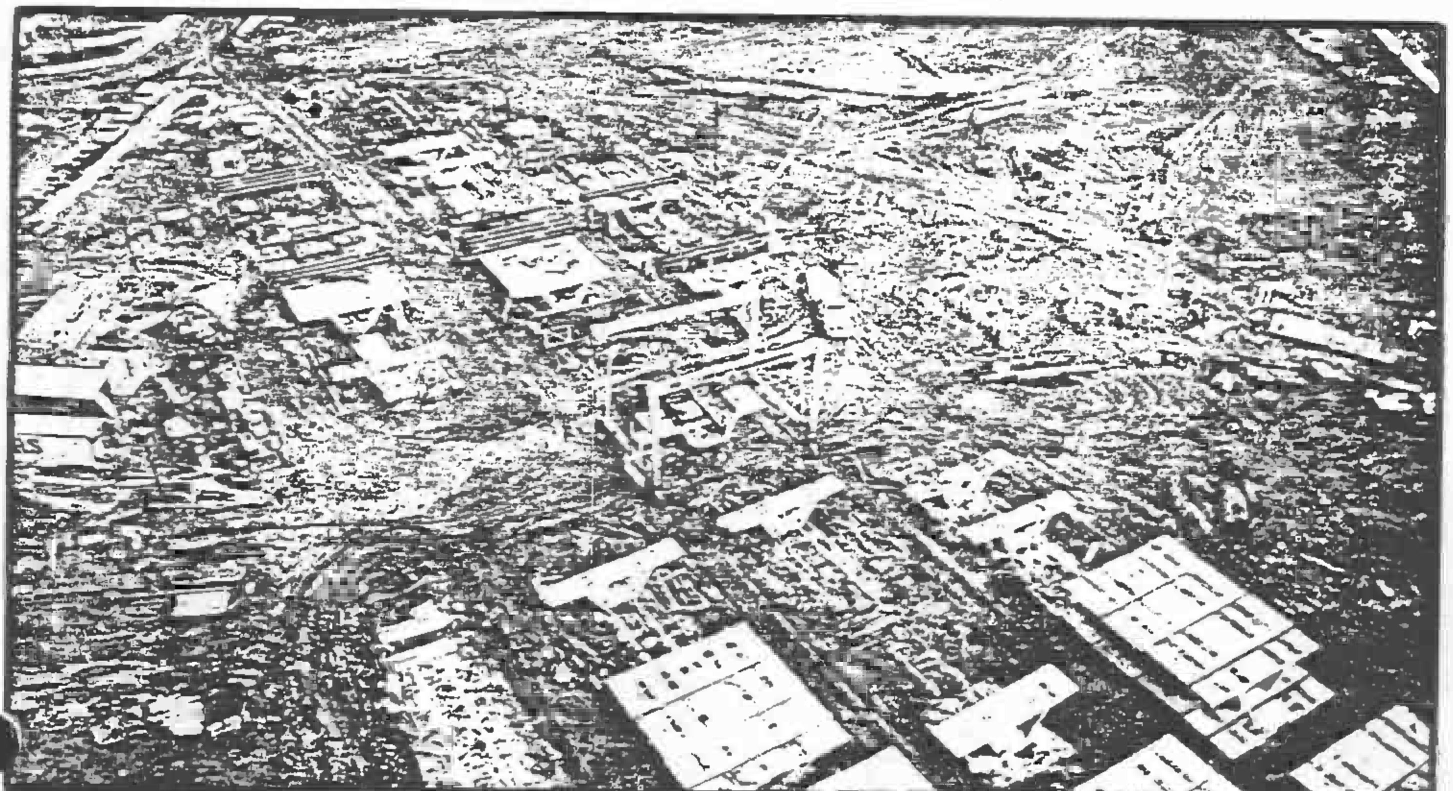


Concrete boxes are supported under their wings to avoid interference.

Figure 22



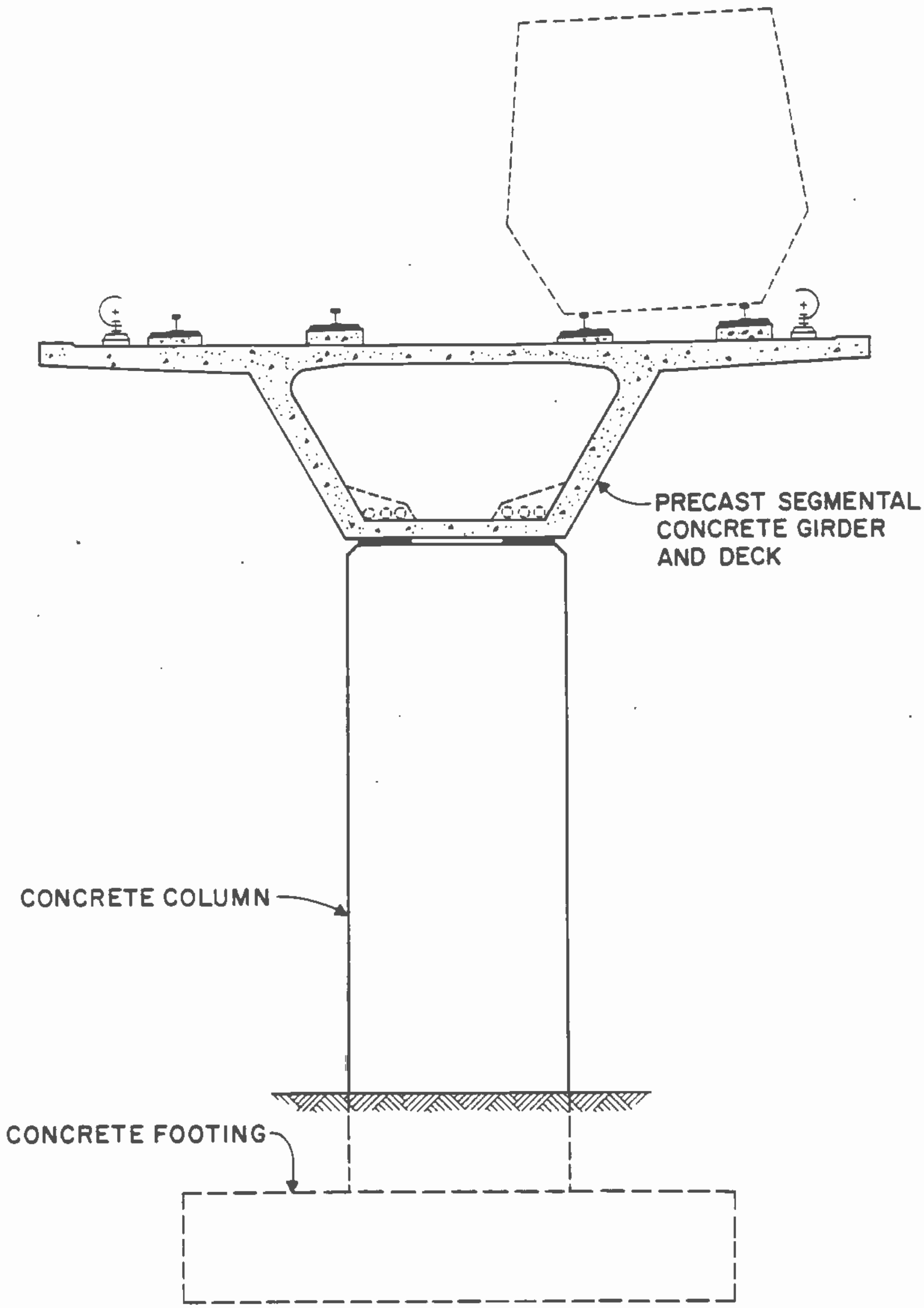
Trusses advanced by a crane in about an hour with rear wheels riding on the concrete boxes.



Large casting yard produces match-cast segments for full spans to be trucked to the erection sites.

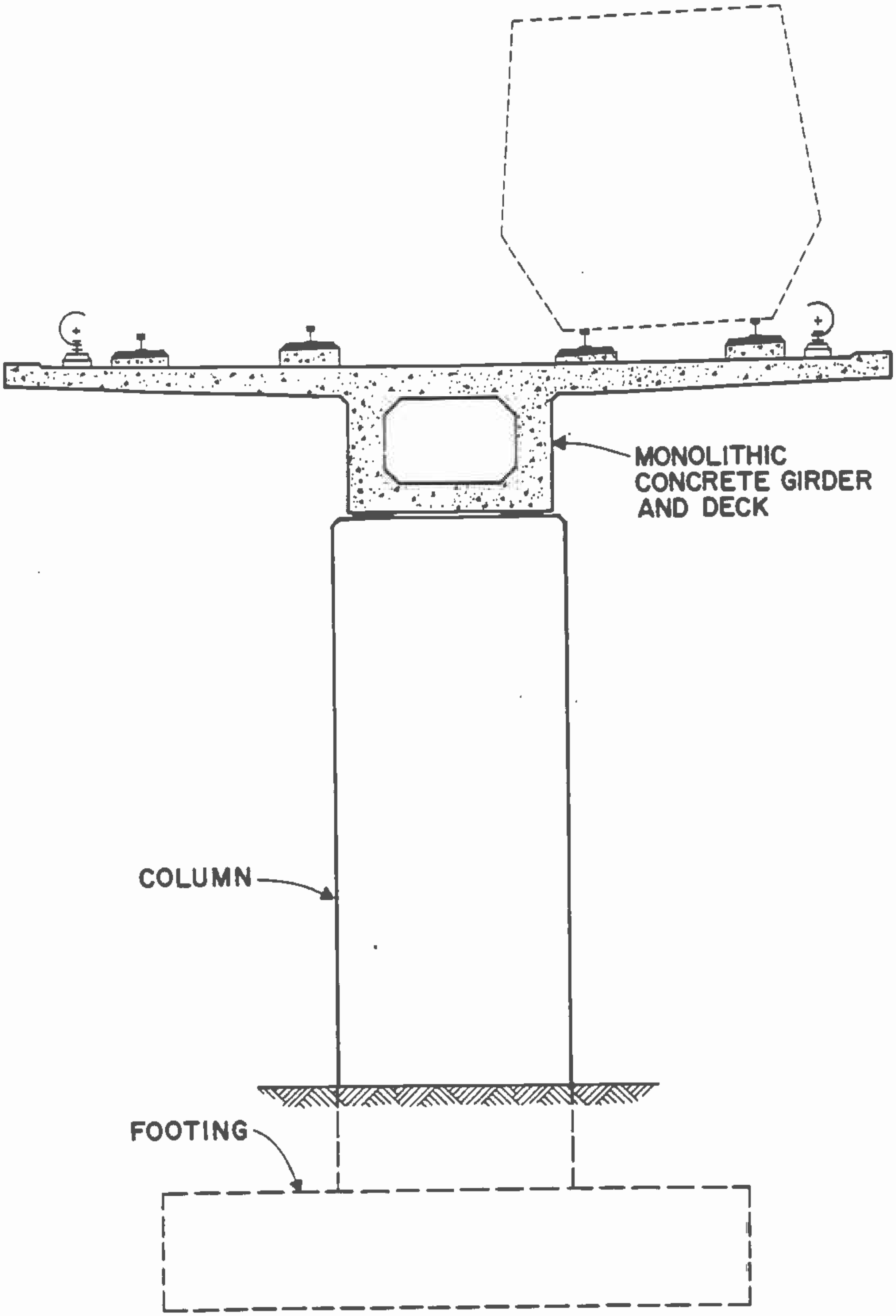
Figure 23

APPENDIX B



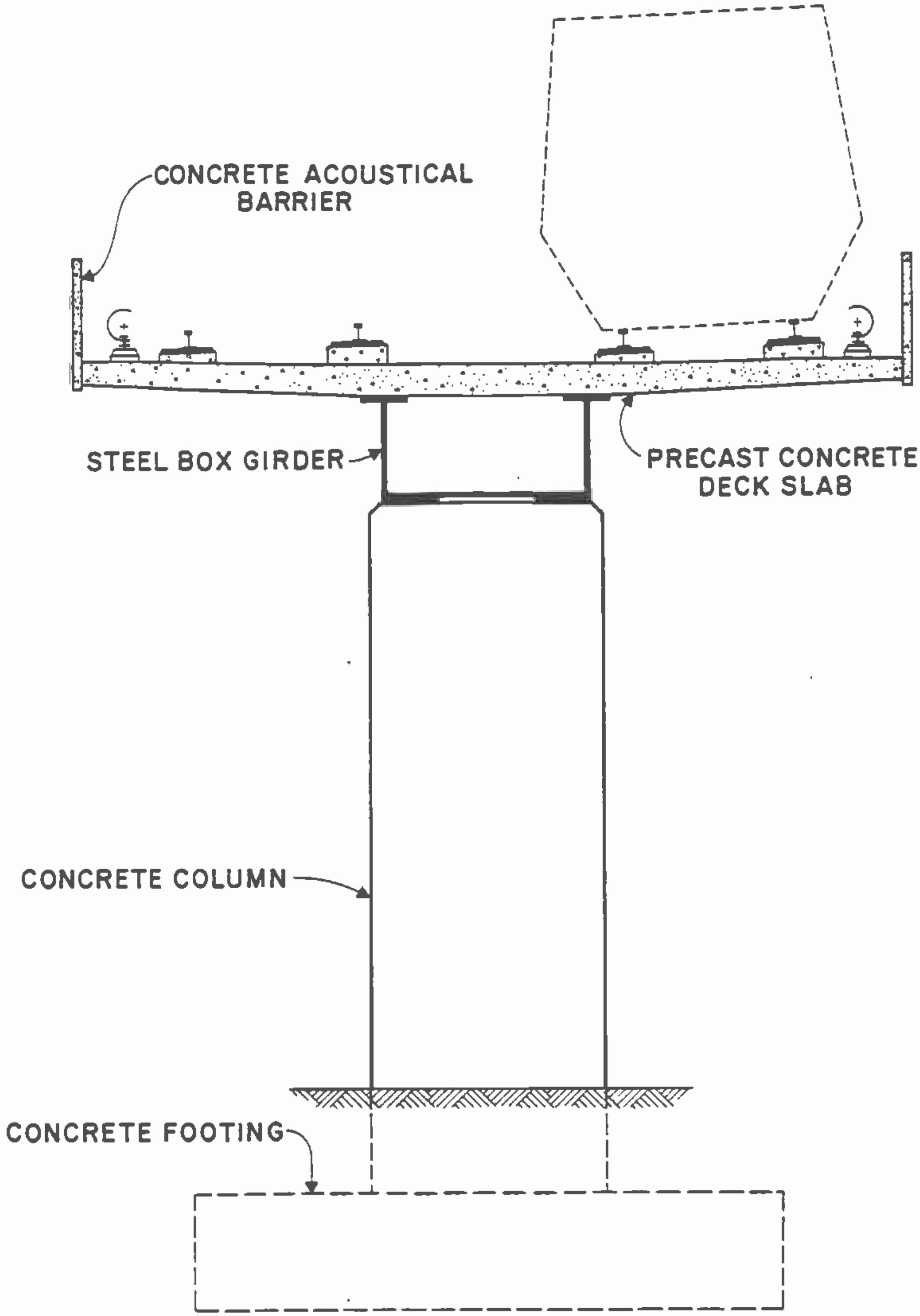
MARTA AERIAL STRUCTURE

Figure 1



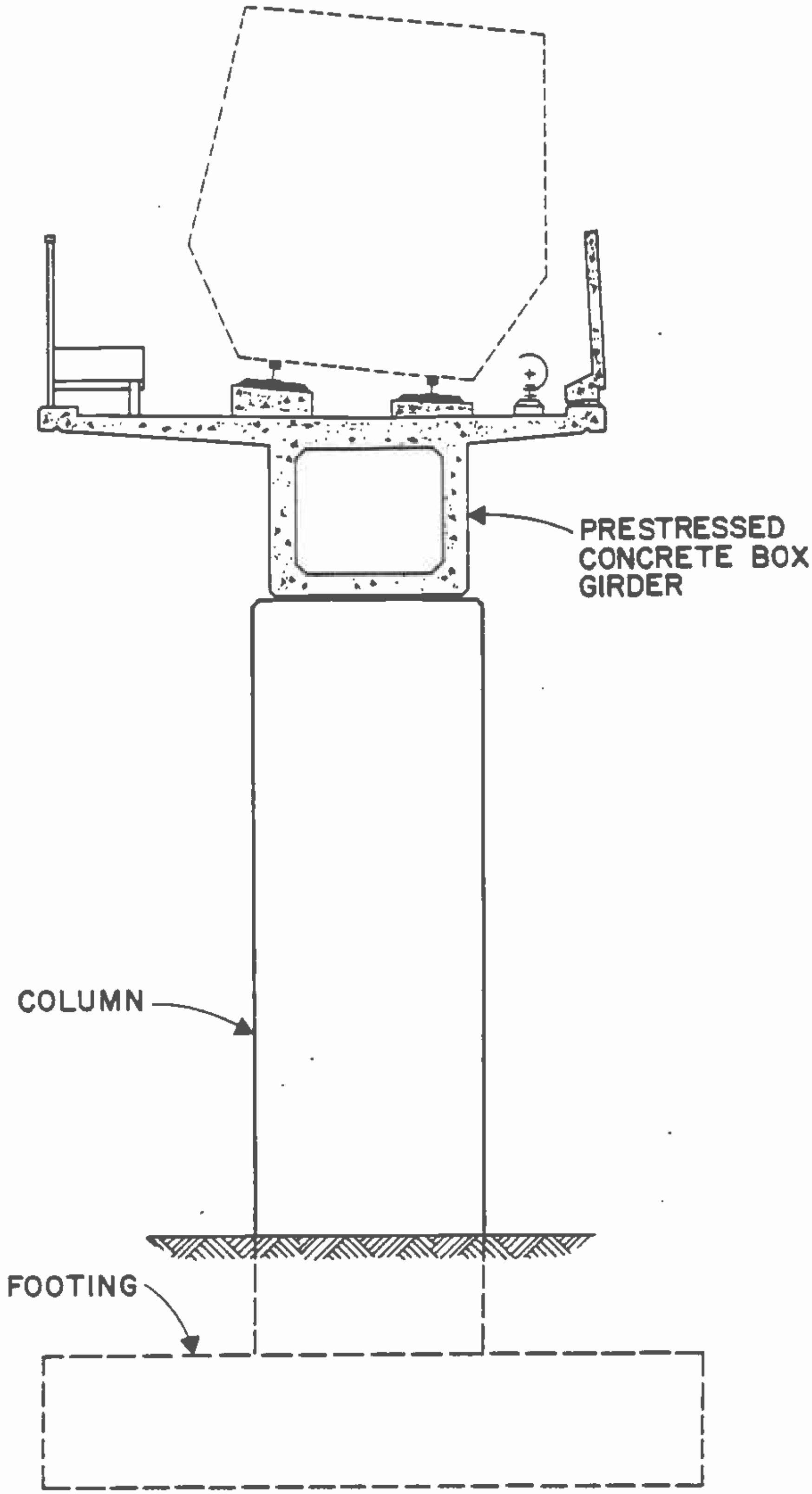
MARTA AERIAL STRUCTURE

Figure 2



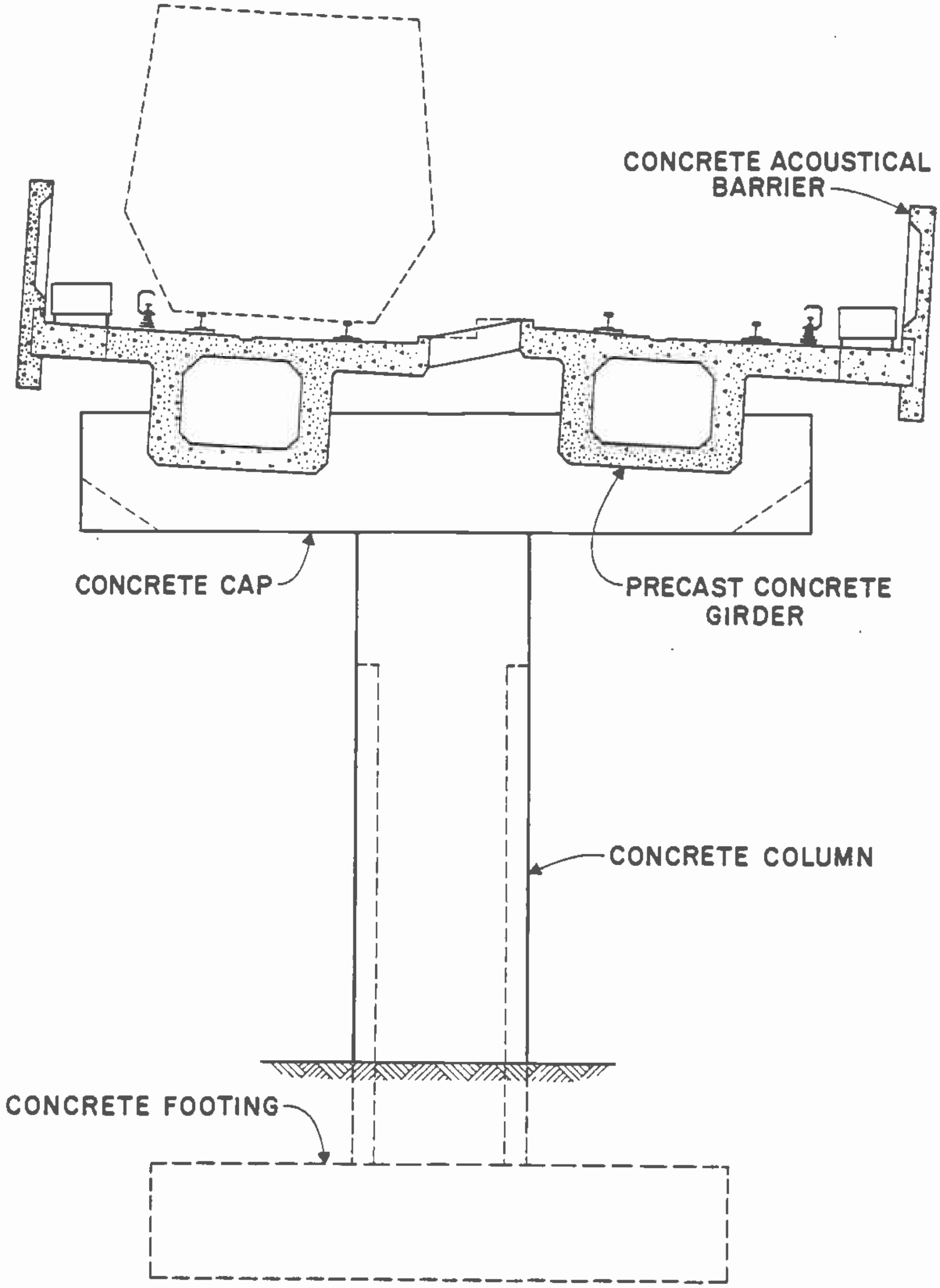
MARTA AERIAL STRUCTURE
STEEL GIRDER OPTION

Figure 3



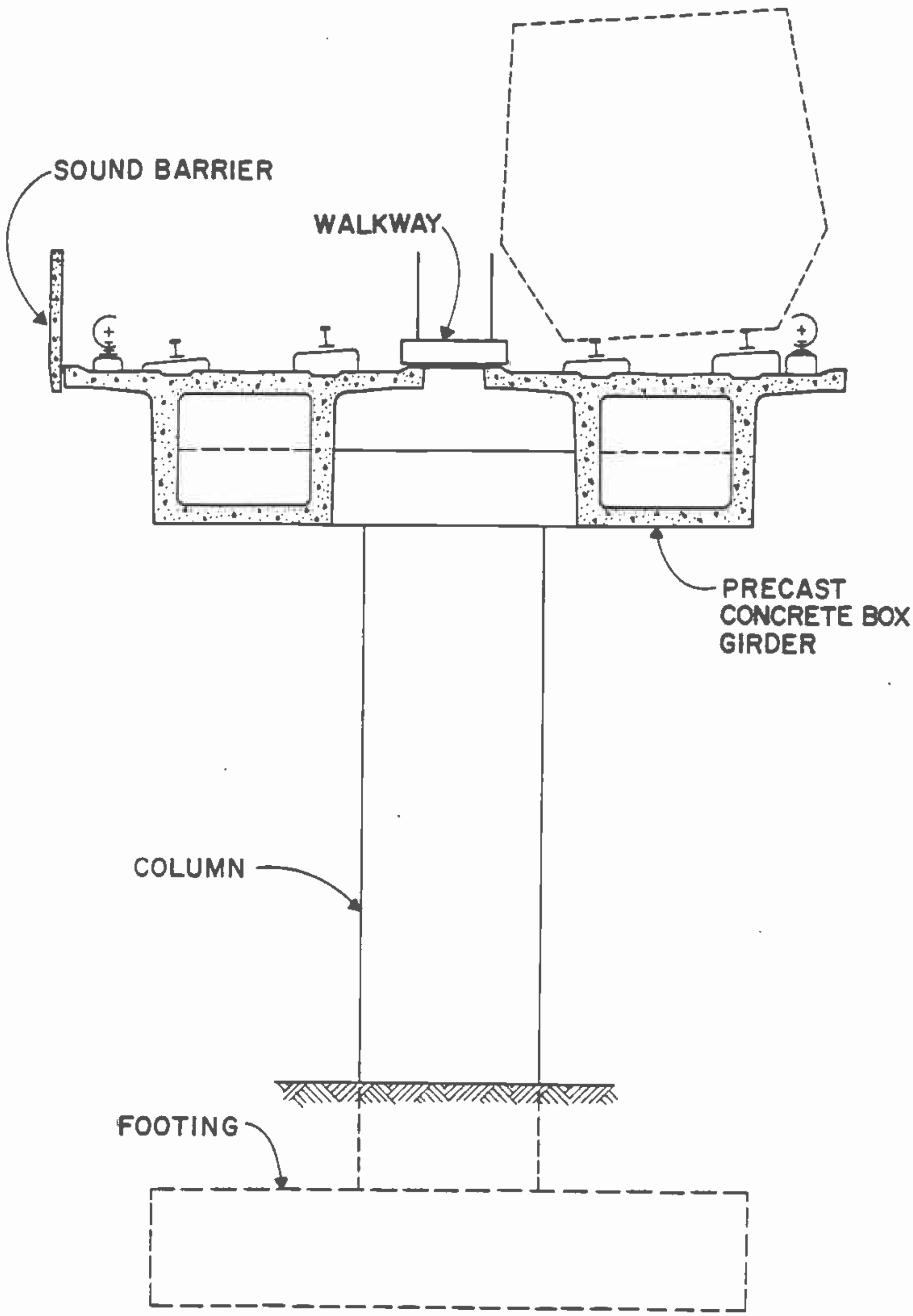
MARTA AERIAL STRUCTURE

Figure 4



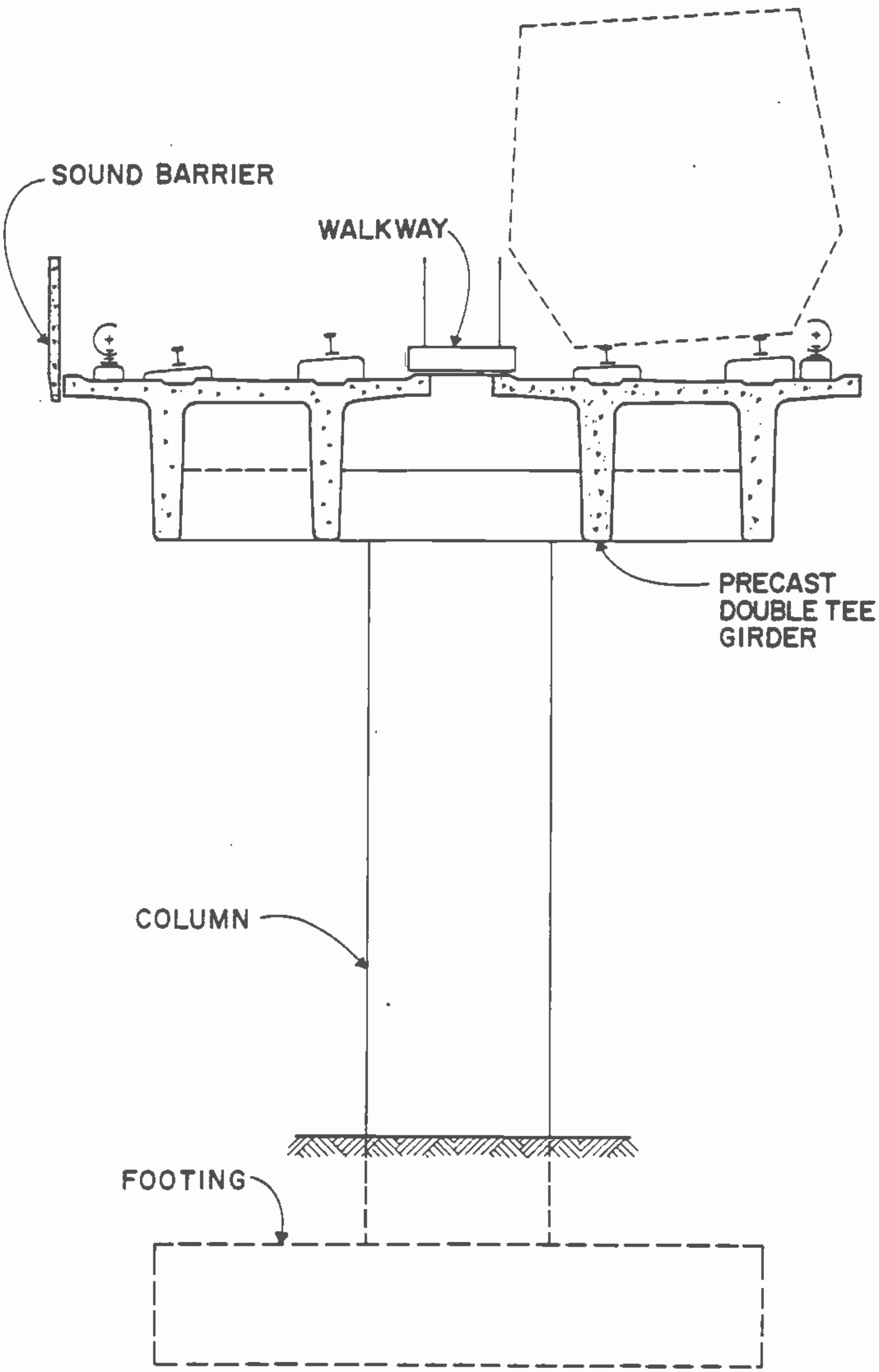
BALTIMORE AERIAL STRUCTURE

Figure 5



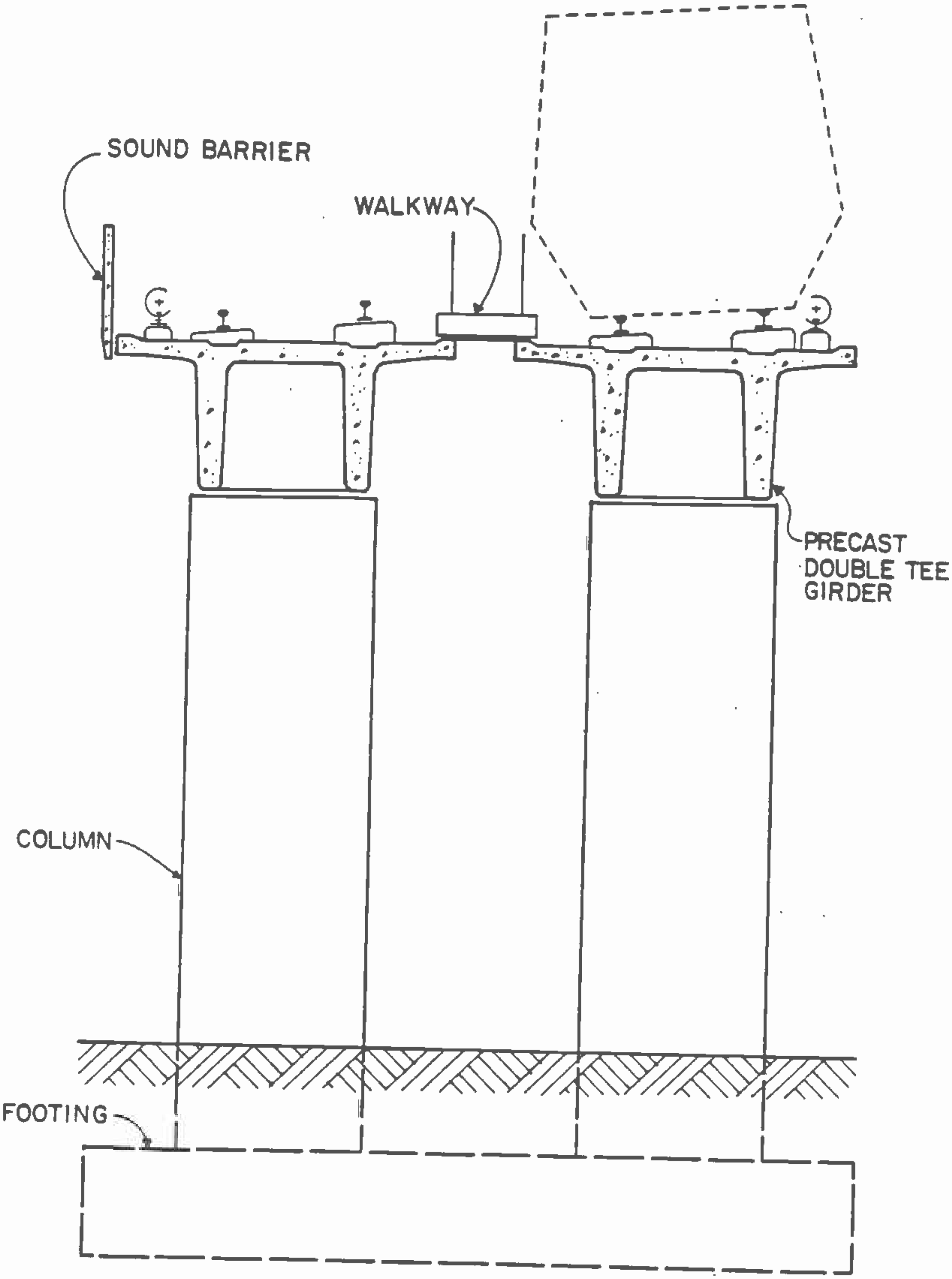
MIAMI AERIAL STRUCTURE
SPANS OVER 80 FEET

Figure 6



MIAMI AERIAL STRUCTURE
SPANS UP TO 80 FEET

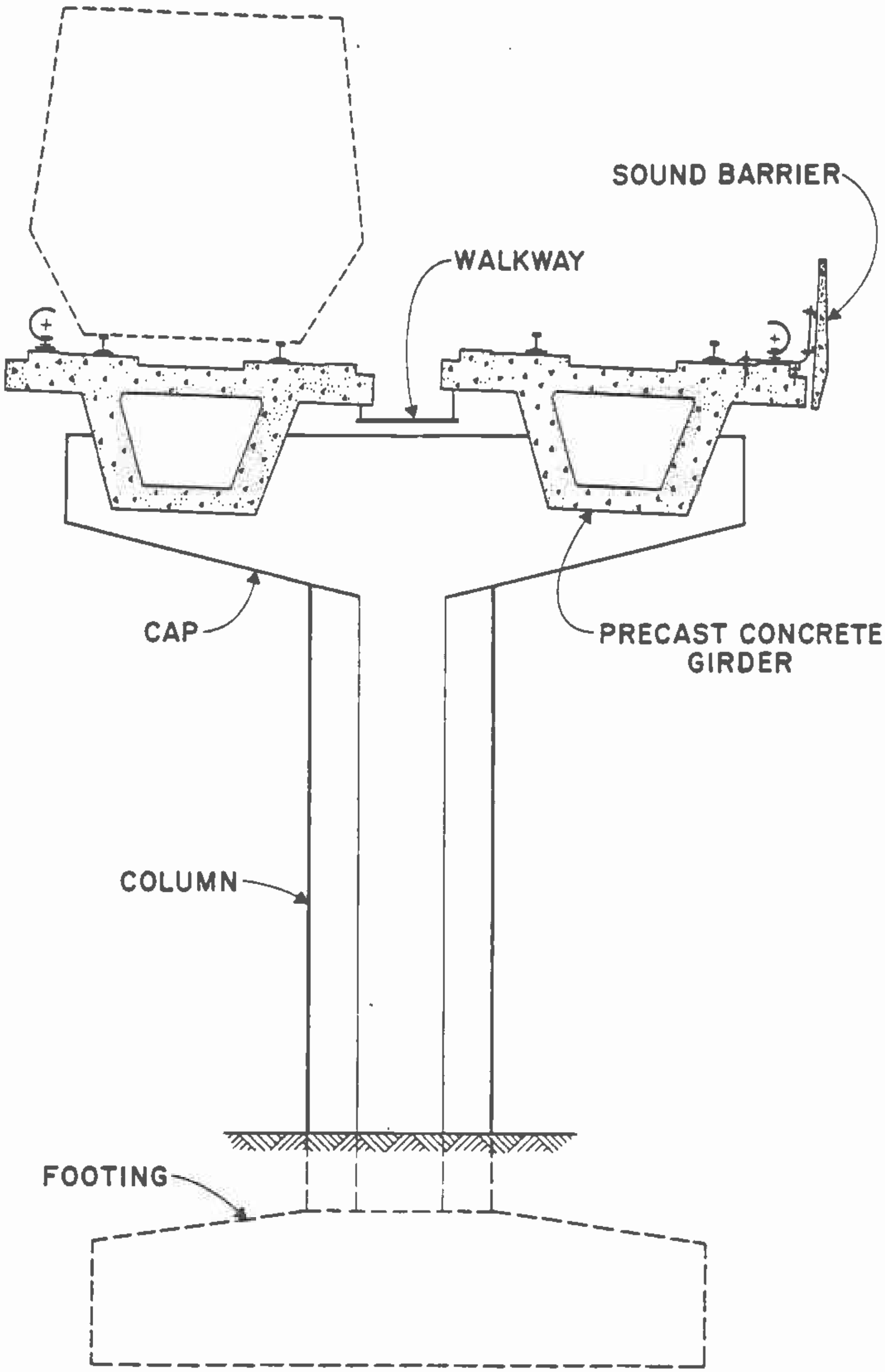
Figure 7



SINGLE COLUMN PIER

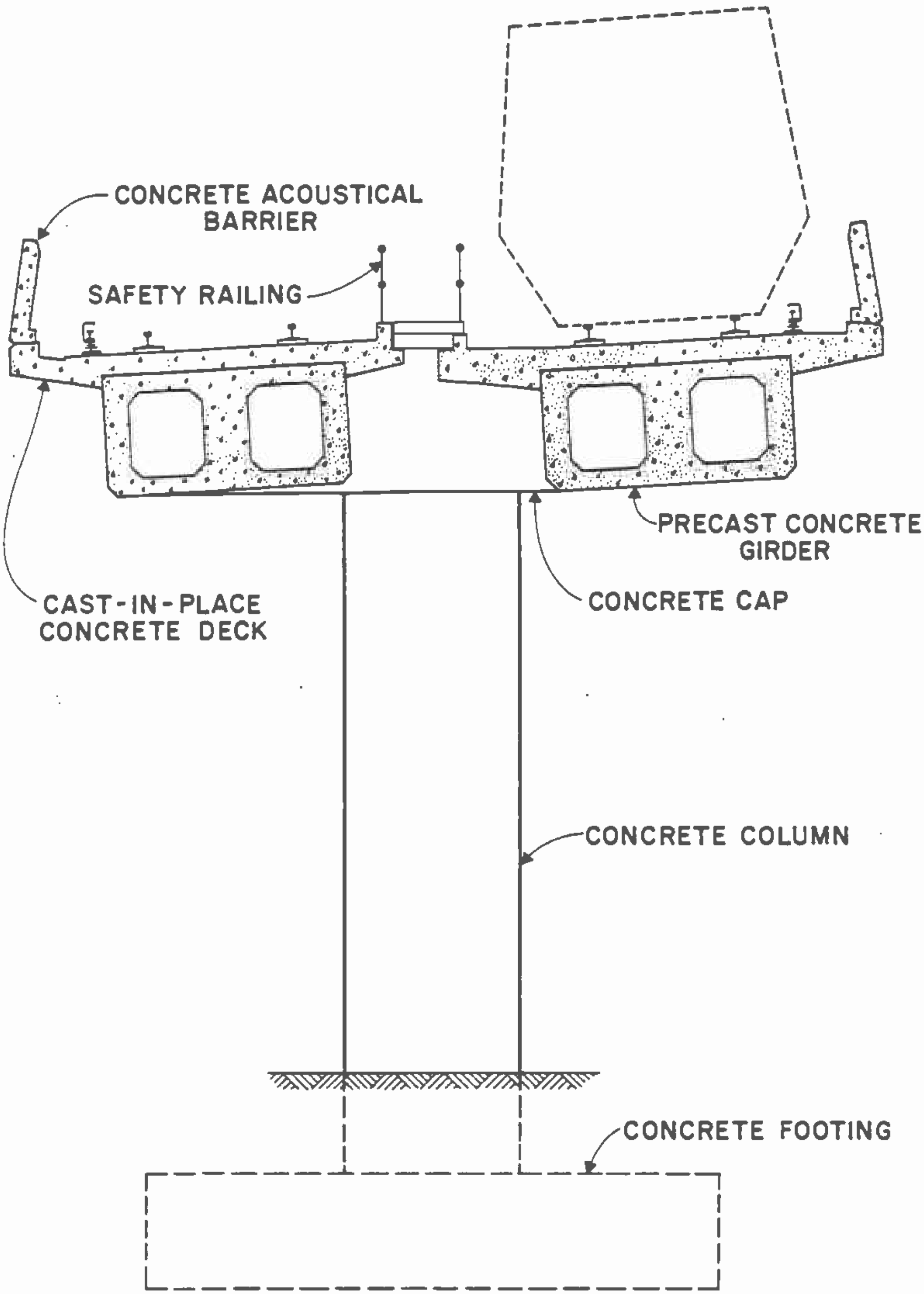
MIAMI AERIAL STRUCTURE SPANS UP TO 80 FEET

Figure 8



BART AERIAL STRUCTURE

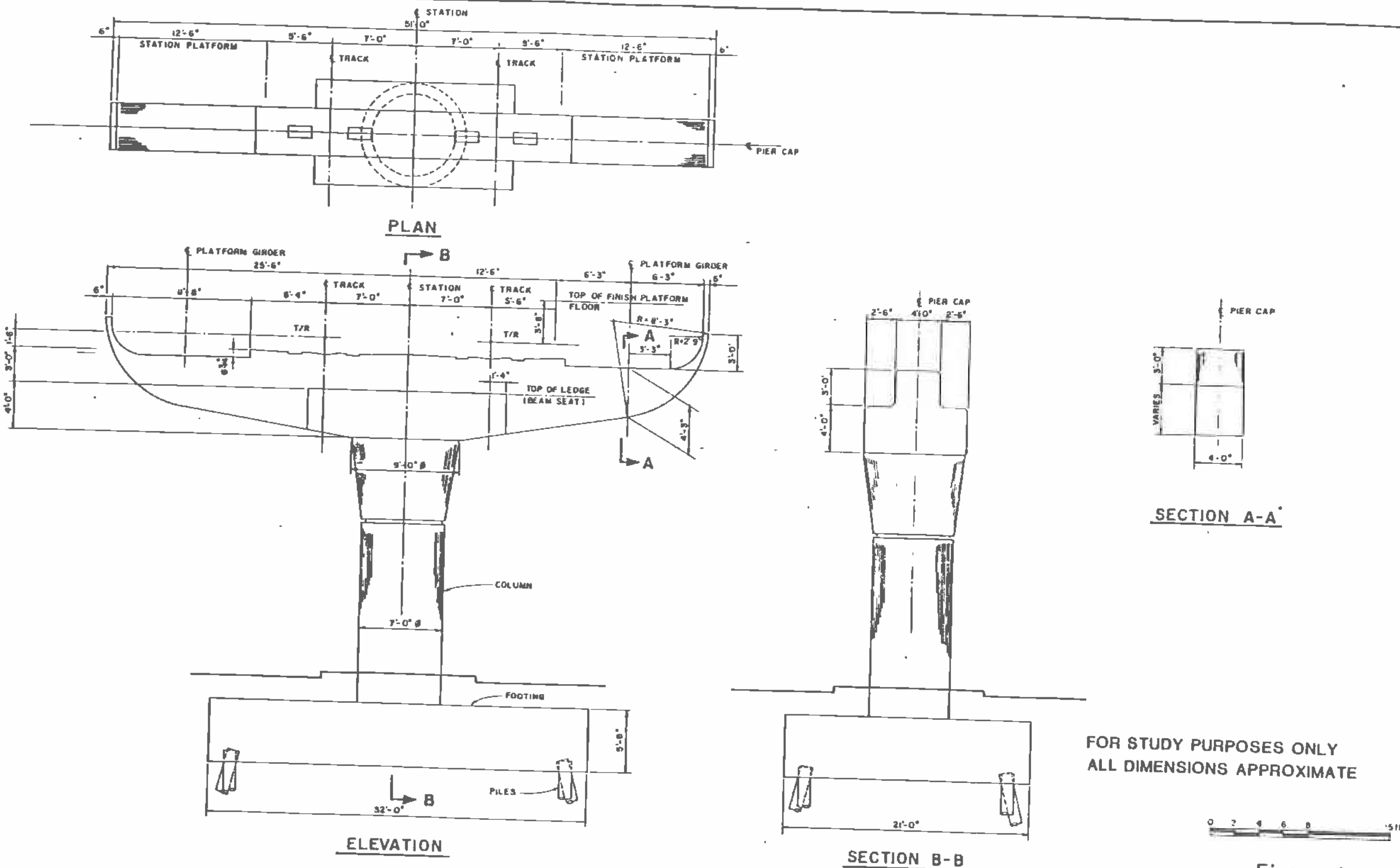
Figure 9



WMATA AERIAL STRUCTURE

Figure 10

APPENDIX C



FOR STUDY PURPOSES ONLY
ALL DIMENSIONS APPROXIMATE

Figure 1

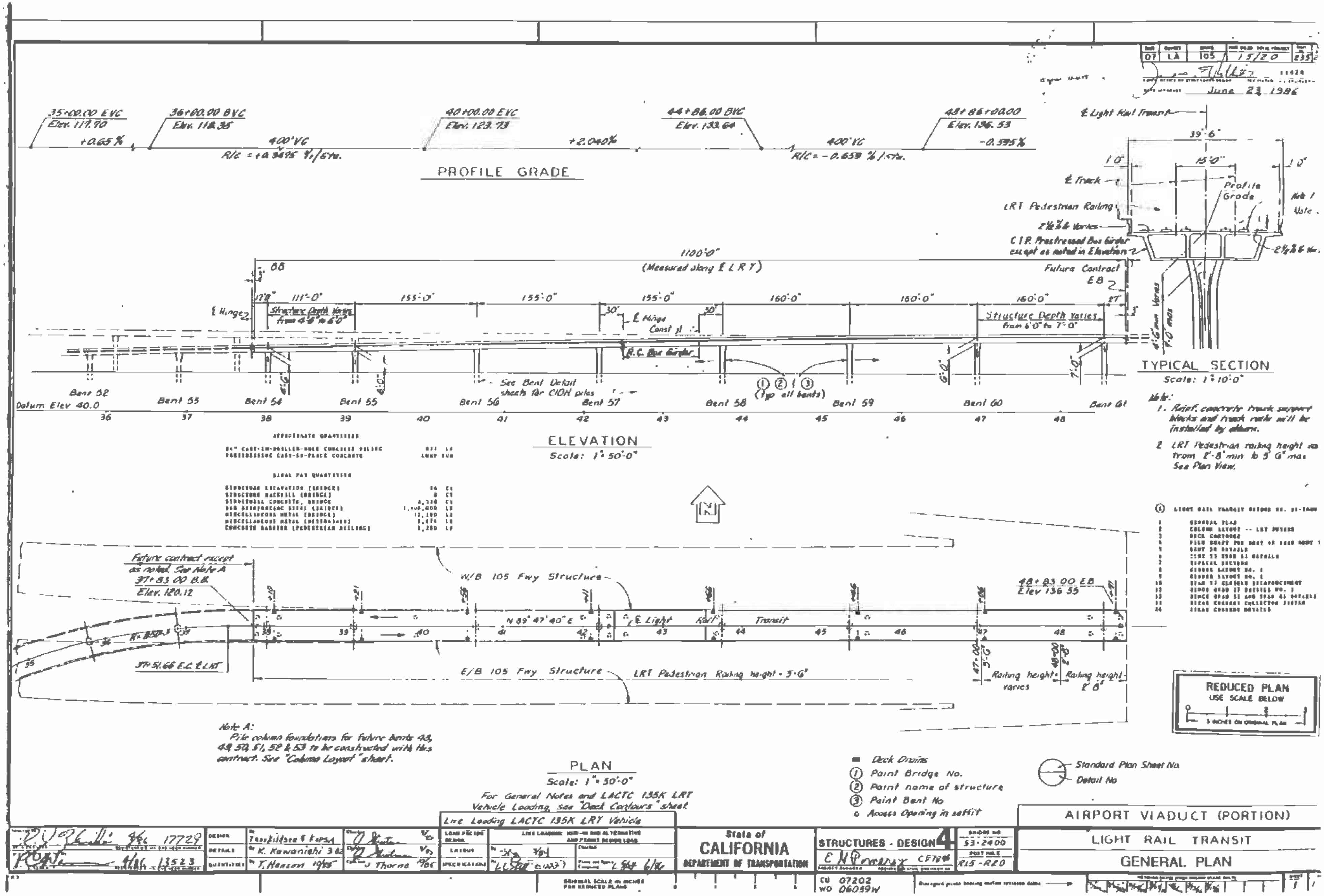
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

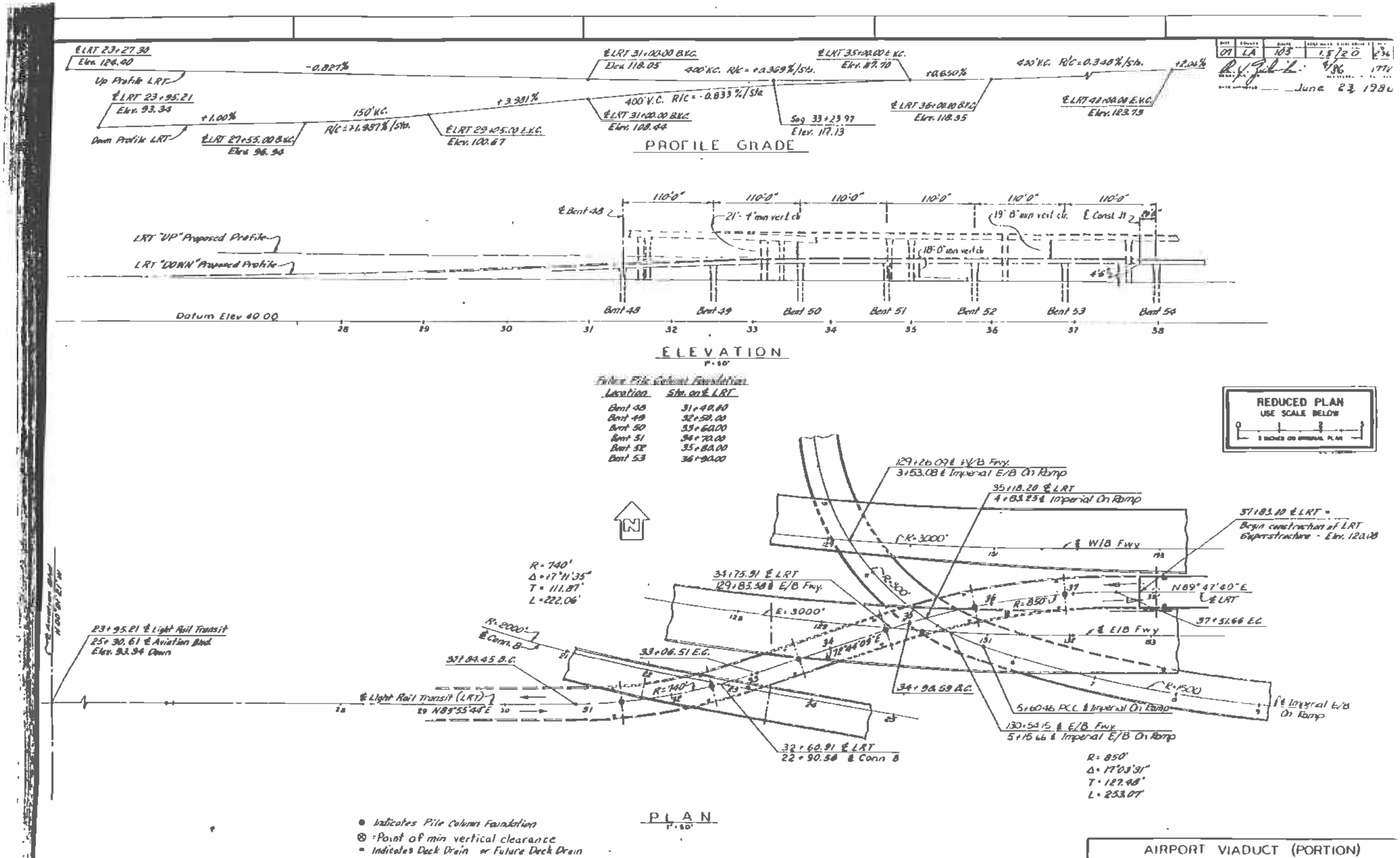
RTD

CORE STUDY

TYPICAL PIER
AT
AERIAL STATION

APPENDIX D


07 LA 105 15/20
June 23, 1986
35+00.00 EVC
Elev. 117.90
+0.65 %
36+00.00 BVC
Elev. 118.35
400' VC
R/C = +0.3475 %/Sta.
40+00.00 EVC
Elev. 123.73
+2.040%
44+86.00 BVC
Elev. 133.64
400' VC
R/C = -0.659 %/Sta.
48+86+00.00
Elev. 136.53
-0.595%
PROFILE GRADE
℄ Light Rail Transit
39'-6"
1'-0"
15'-0"
1'-0"
℄ Track
Profile Grade
LRT Pedestrian Railing
C.I.P. Prestressed Box Girder except as noted in Elevation
Future Contract EB
TYPICAL SECTION
Scale: 1" = 10'-0"
1100'-0"
(Measured along ℄ L R T)
Structure Depth Varies from 4'-6" to 6'-0"
111'-0"
155'-0"
155'-0"
155'-0"
160'-0"
160'-0"
160'-0"
Structure Depth Varies from 6'-0" to 7'-0"
℄ Hinge
℄ Hinge Const. jt.
R.C. Box Girder
See Bent Detail sheets for CIDH piles
① ② ③ (Typ all bents)
Datum Elev 40.0
Bent 52
Bent 53
Bent 54
Bent 55
Bent 56
Bent 57
Bent 58
Bent 59
Bent 60
Bent 61
ELEVATION
Scale: 1" = 50'-0"
Note:
1. Reinf. concrete track support blocks and track rails will be installed by others.
2. LRT Pedestrian railing height varies from 2'-8" min to 5'-6" max. See Plan View.
Future contract except as noted. See Note A
37+83.00 B.B.
Elev. 120.12
W/B 105 Fwy Structure
N 89° 47' 40" E
℄ Light Rail Transit
48+83.00 EB
Elev 136.55
37+51.66 E.C. ℄ LRT
E/B 105 Fwy Structure
LRT Pedestrian Railing height = 5'-6"
Railing height varies
Railing height 2'-8"
REDUCED PLAN
USE SCALE BELOW
Note A:
Pile column foundations for future bents 48, 49, 50, 51, 52 & 53 to be constructed with this contract. See "Column Layout" sheet.
PLAN
Scale: 1" = 50'-0"
For General Notes and LACTC 135K LRT Vehicle Loading, see "Deck Contours" sheet
Live Loading LACTC 135K LRT Vehicle
Deck Drains
① Paint Bridge No.
② Paint name of structure
③ Paint Bent No
Access Opening in soffit
Standard Plan Sheet No.
Detail No
AIRPORT VIADUCT (PORTION)
State of CALIFORNIA DEPARTMENT OF TRANSPORTATION
STRUCTURES - DESIGN 4
53-2400
R15-R20
LIGHT RAIL TRANSIT
GENERAL PLAN
17729
13523
Tsasilidse & Korsa
K. Kawanishi
T. Hanson
J. Thorne
CU 07202
WO 06059W



DESIGN	E H Pomeroy 4/85
DETAILS	Fujii
QUANTITIES	T. Hansen 10/85

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

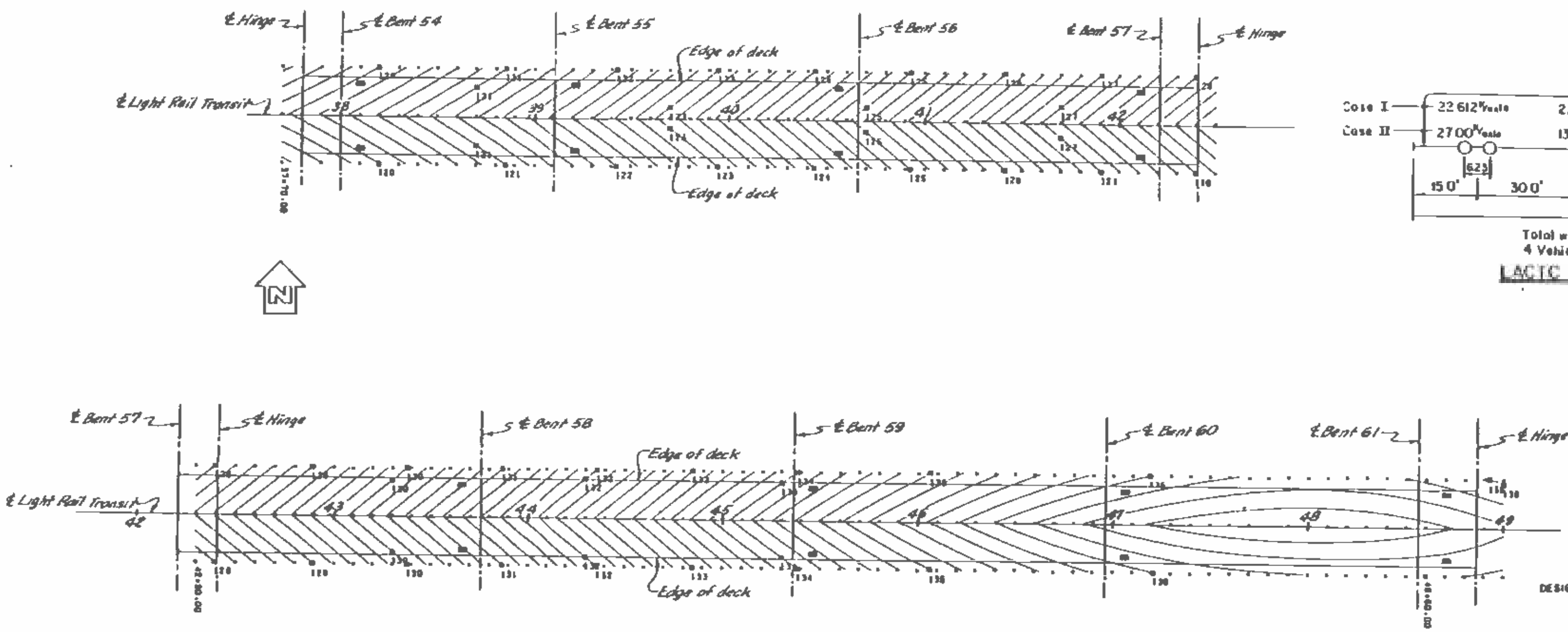
DIVISION OF STRUCTURES
STRUCTURE DESIGN 4

BRIDGE NO. 53 2400
POST MILE R15-R20

AIRPORT VIADUCT (PORTION)
LIGHT RAIL TRANSIT FUTURE
COLUMN LAYOUT

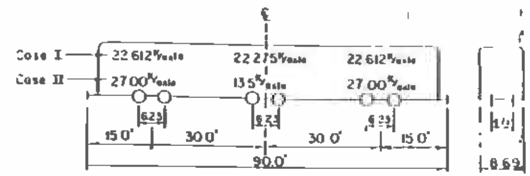
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	LA	105	15/20		237

June 23, 1986



PLAN
1" = 30'

Note:
□ - Indicates area foot contours.
× - 10' intervals along station line.
Contours do not include camber.
▬ - Deck Drains



Total weight = 135 Kips
4 Vehicles per train

LACTC LRT VEHICLE

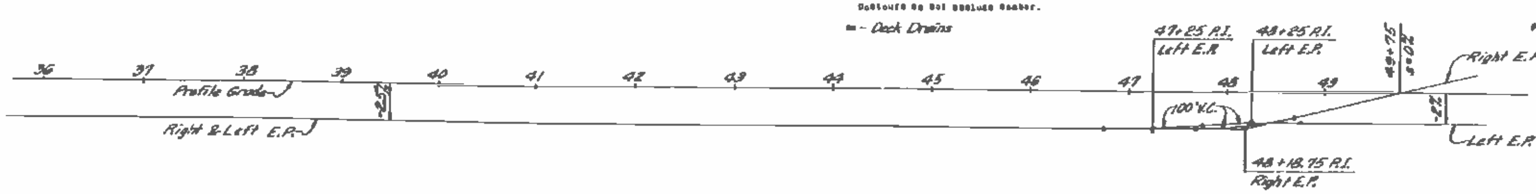
GENERAL NOTES
LOAD FACTOR DESIGN

DESIGN. BRIDGE DESIGN SPECIFICATIONS
(1983 AASHTO with Interims and Revisions by CALTRANS.

LIVE LOADING: HS20-44 and alternative and permit design load.

REINFORCED CONCRETE: f_y = 60,000 psi
f'_c = 3600 psi
n = 8
Transverse deck slabs (working Stress Design)
f_s = 60,000 psi
f_c = 1,800 psi
n = 10

PRESTRESSED CONCRETE See "Prestressing Notes"



SUPERELEVATION DIAGRAM
No Scale

REDUCED PLAN
USE SCALE BELOW
0 1 2 3
INCHES ON ORIGINAL PLAN

DESIGN	E. M. Pomeroy 7/85		
DETAILS	T.A. Hanson 9/85		
QUANTITIES	T. Hanson 10/85	J. Thorne	10/85

State of
CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4
E. M. Pomeroy CE 7845

BRIDGE NO. 53-2400
POST MILE R1.5-R2.0

AIRPORT VIADUCT (PORTION)
LIGHT RAIL TRANSIT
DECK CONTOURS

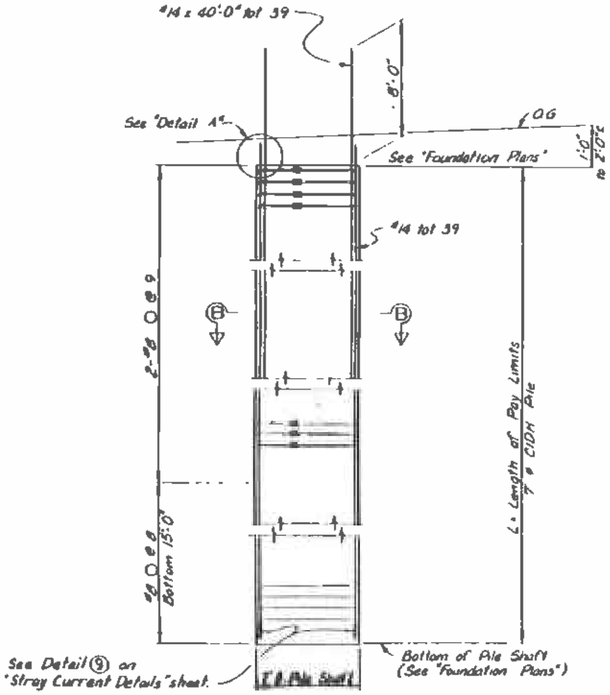
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS

CU 07202
WO 06039W
053201

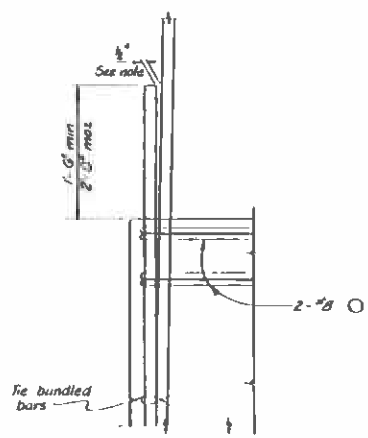
3

07	LA	105	L5/20	236

June 27, 1986

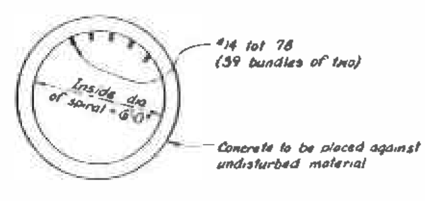


ELEVATION
¼" = 1'-0"



DETAIL A
No Scale

Note
A clearance of ½" shall be provided in order to permit welding without damage to adjacent longitudinal bar



SECTION B-B
No Scale

See Foundation Details sheets for details not shown.

REDUCED PLAN
USE SCALE BELOW

AIRPORT VIADUCT (PORTION)

LIGHT RAIL TRANSIT

PILE SHAFT FOR BENT 48 THRU BENT

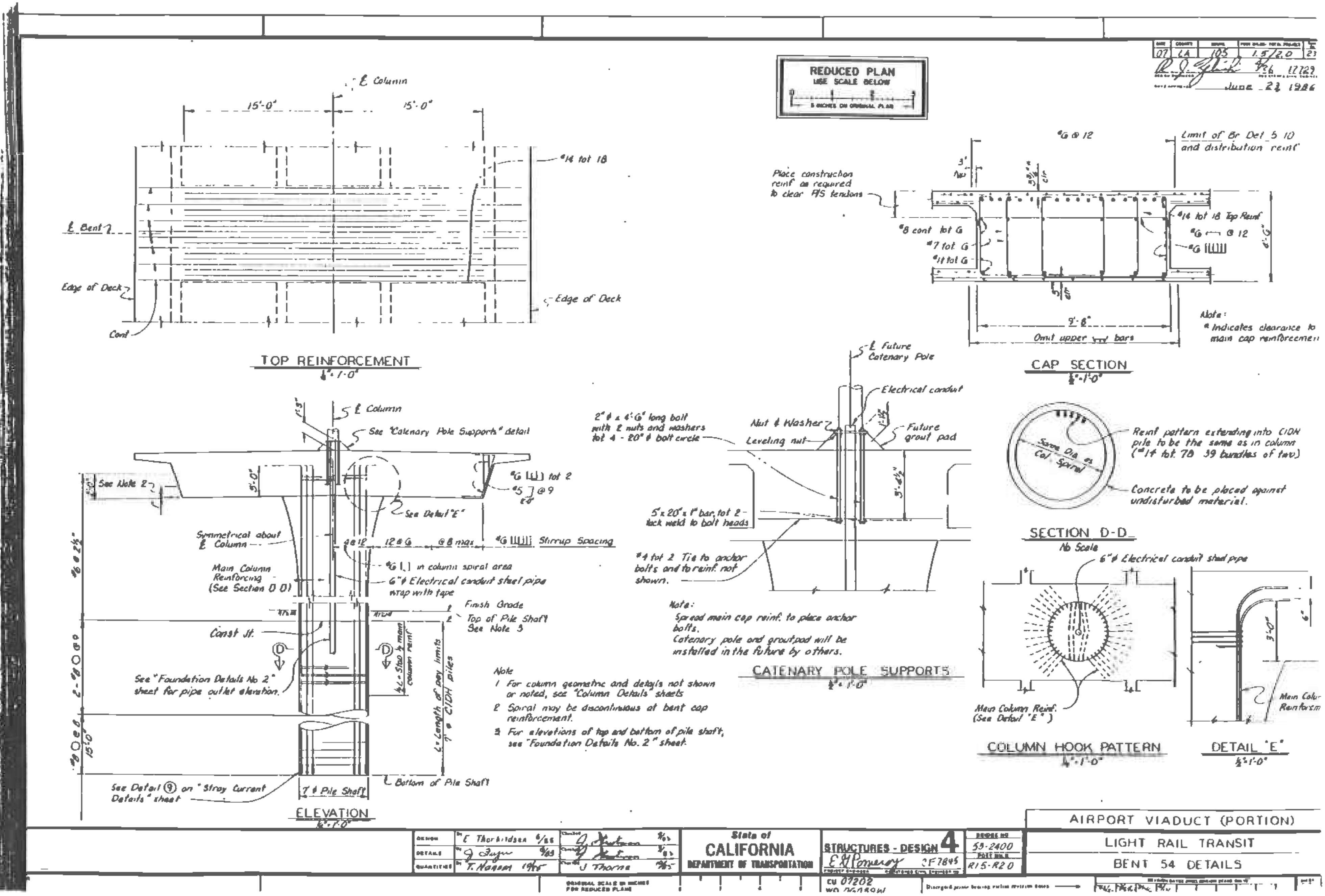
State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4

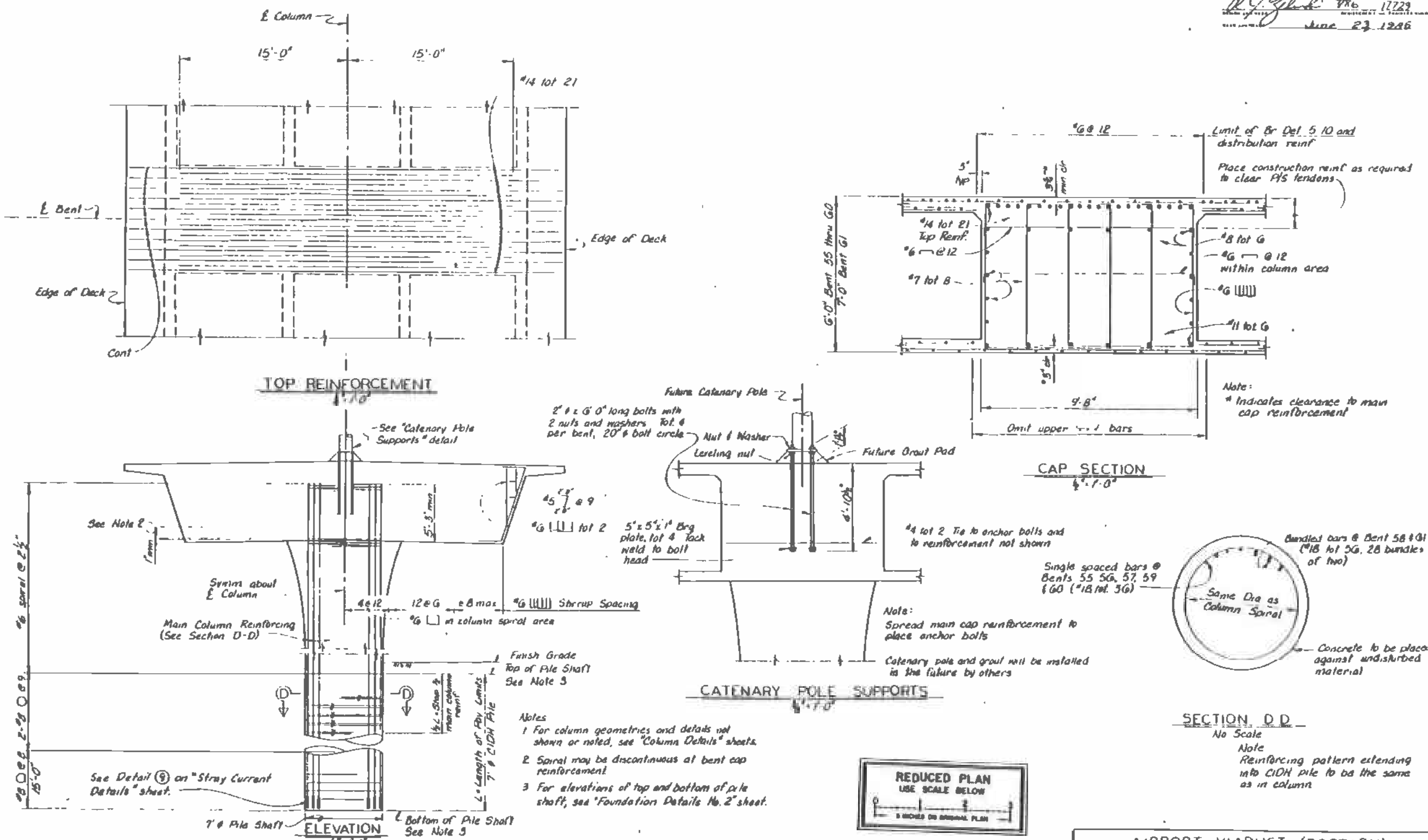
55-2400

R15-R20

CU 07202
WO 060394



REDUCED PLAN
USE SCALE BELOW
07 LA 105 1.5/2.0
June 23 1986
TOP REINFORCEMENT
¼" = 1'-0"
℄ Column
15'-0"
15'-0"
#14 tot 18
℄ Bent
Edge of Deck
Edge of Deck
Cont
CAP SECTION
½" = 1'-0"
#G @ 12
Limit of Br Det 5-10 and distribution reinf
Place construction reinf as required to clear P/S tendons
#8 cont tot G
#7 tot G
#11 tot G
#14 tot 18 Top Reinf
#G @ 12
9'-8"
Omit upper bars
Note:
* Indicates clearance to main cap reinforcement
SECTION D-D
No Scale
Reinf pattern extending into CIDH pile to be the same as in column (#14 tot 78 39 bundles of two)
Concrete to be placed against undisturbed material.
Same Dia as Col. Spiral
CATENARY POLE SUPPORTS
½" = 1'-0"
℄ Future Catenary Pole
Electrical conduit
Future grout pad
Nut & Washer
Leveling nut
2" ⌀ x 4'-6" long bolt with 2 nuts and washers tot 4 - 20" ⌀ bolt circle
5 x 20 x 1" bar, tot 2 - tack weld to bolt heads
#4 tot 2 Tie to anchor bolts and to reinf. not shown.
Note:
Spread main cap reinf. to place anchor bolts.
Catenary pole and groutpad will be installed in the future by others.
ELEVATION
¼" = 1'-0"
℄ Column
See "Catenary Pole Supports" detail
See Note 2
#G tot 2
#5 @ 9
See Detail "E"
Symmetrical about ℄ Column
#G Stirrup Spacing
Main Column Reinforcing (See Section D-D)
#G in column spiral area
6" ⌀ Electrical conduit steel pipe wrap with tape
Finish Grade
Top of Pile Shaft See Note 3
Const Jt.
See "Foundation Details No 2" sheet for pipe outlet elevation.
See Detail 9 on "Stray Current Details" sheet
7' ⌀ Pile Shaft
Bottom of Pile Shaft
L = Length of pay limits 7' ⌀ CIDH piles
Note
1 For column geometric and details not shown or noted, see "Column Details" sheets
2 Spiral may be discontinuous at bent cap reinforcement.
3 For elevations of top and bottom of pile shaft, see "Foundation Details No. 2" sheet.
COLUMN HOOK PATTERN
¼" = 1'-0"
6" ⌀ Electrical conduit steel pipe
Main Column Reinf. (See Detail "E")
DETAIL "E"
½" = 1'-0"
Main Column Reinforcement
AIRPORT VIADUCT (PORTION)
LIGHT RAIL TRANSIT
BENT 54 DETAILS
E Thorkildsen
T. Nassem
J Thorne
State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION
STRUCTURES - DESIGN 4
E.G. Pomeroy
CE 7845
53-2400
R15-R20
CU 07202



07	LA	105	1.5/2.0	240	283

June 23 1986

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4

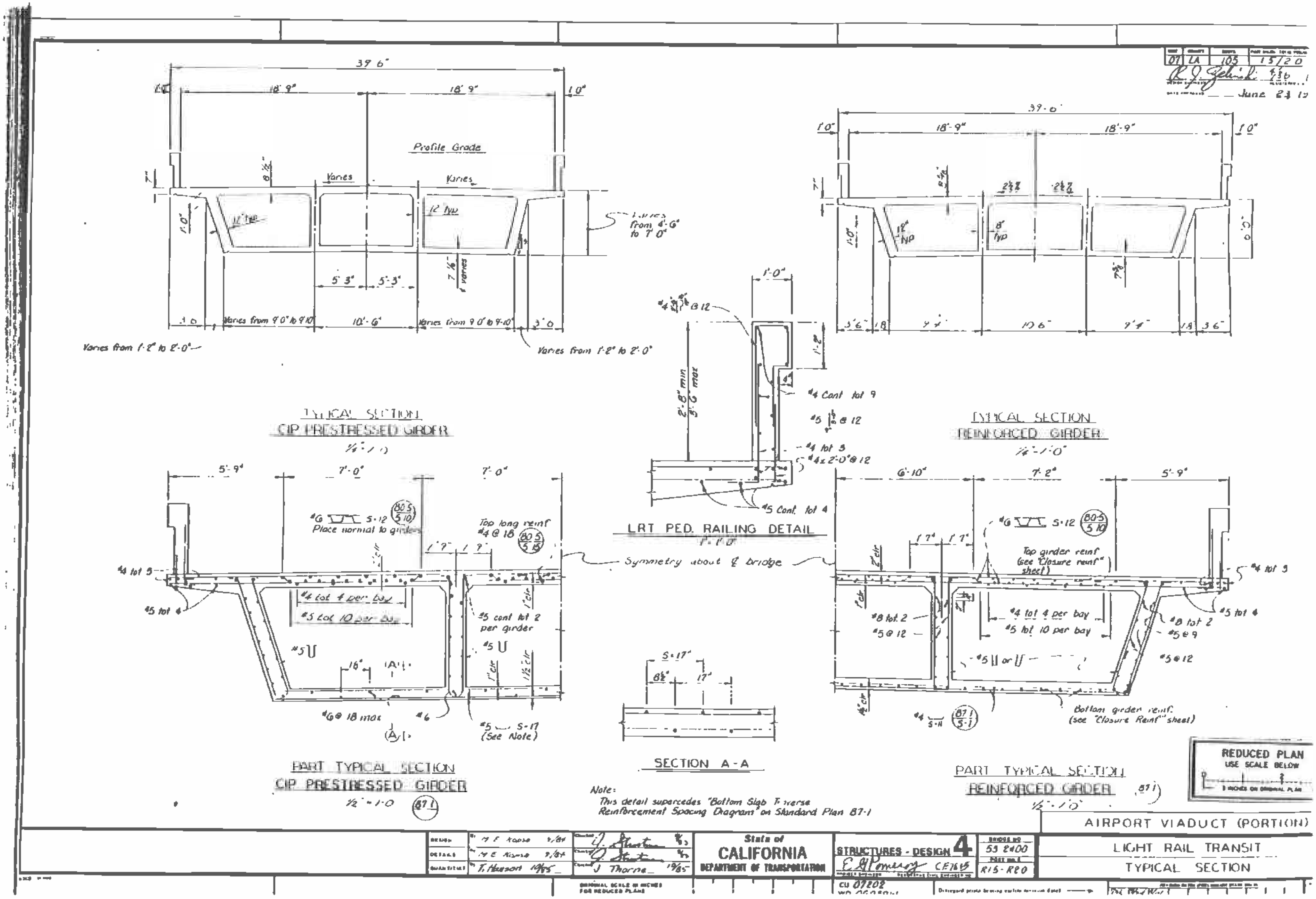
DESIGN: J. Thorne · DETAILS · QUANTITIES: T. Halsea

BRIDGE NO. 53-2400
POST MILE R15-R20

CU 07202
WO 06059W

AIRPORT VIADUCT (PORTION)
LIGHT RAIL TRANSIT
BENT 55 THRU 61 DETAILS

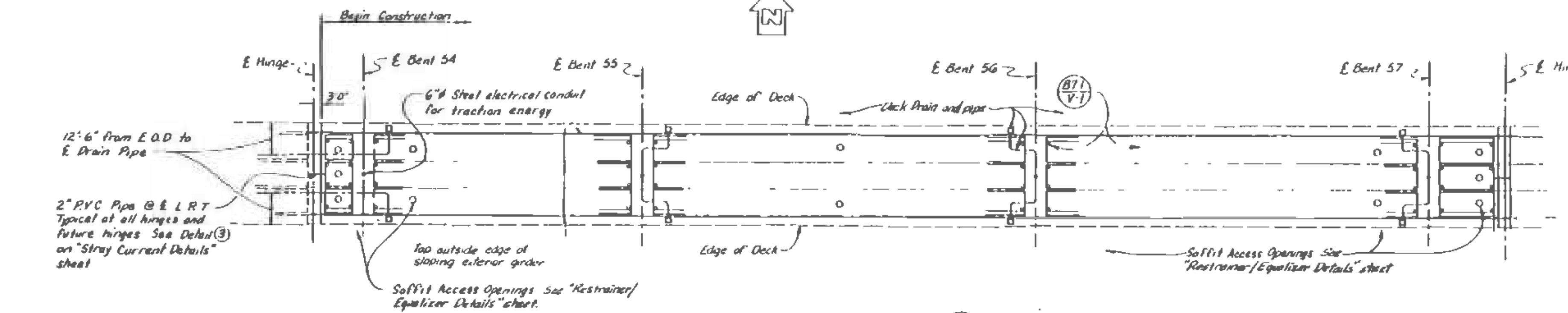
SHEET 6 OF 14



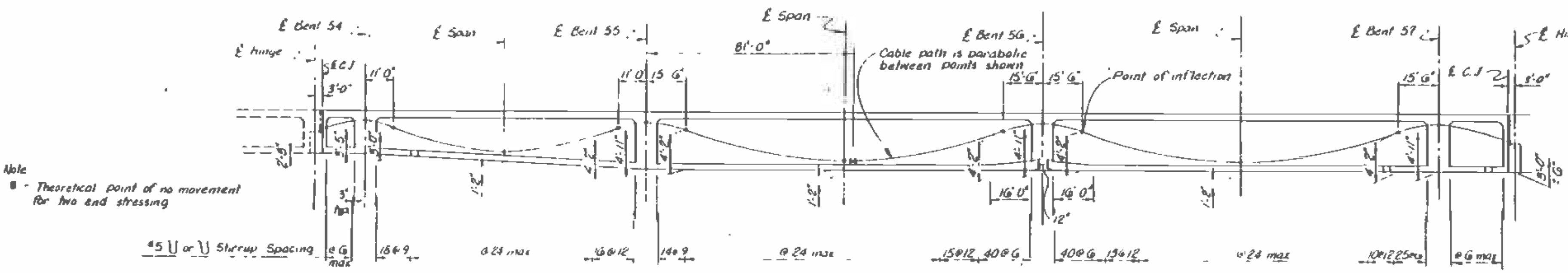
TYPICAL SECTION
CIP PRESTRESSED GIRDER
¼" = 1'-0"
TYPICAL SECTION
REINFORCED GIRDER
¼" = 1'-0"
39'-6"
18'-9"
18'-9"
1'-0"
Profile Grade
Varies
12" typ
Varies from 4'-6" to 7'-0"
5'-3"
10'-6"
Varies from 9'-0" to 9'-10"
3'-0"
Varies from 1'-2" to 2'-0"
39'-0"
8" typ
3'-6"
LRT PED. RAILING DETAIL
1" = 1'-0"
#4 Cont tot 9
#5 Cont tot 4
Symmetry about ℄ bridge
2'-8" min
3'-6" max
PART TYPICAL SECTION
CIP PRESTRESSED GIRDER
½" = 1'-0"
#4 tot 4 per bay
#5 tot 10 per bay
#5 cont tot 2 per girder
Top long reinf #4 @ 18
Place normal to girders
#6 @ 18 max
#5 tot 4
#4 tot 5
SECTION A-A
PART TYPICAL SECTION
REINFORCED GIRDER
½" = 1'-0"
Top girder reinf (See "Closure reinf" sheet)
Bottom girder reinf. (see "Closure Reinf" sheet)
#8 tot 2
#5 @ 12
#5 @ 9
Note:
This detail supercedes "Bottom Slab Transverse Reinforcement Spacing Diagram" on Standard Plan B7-1
REDUCED PLAN
USE SCALE BELOW
07 LA 105 15/20
June 23
AIRPORT VIADUCT (PORTION)
LIGHT RAIL TRANSIT
TYPICAL SECTION
State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION
STRUCTURES - DESIGN 4
53 2400
R15-R20
CU 07202

07	LA	105	15/2.0	232

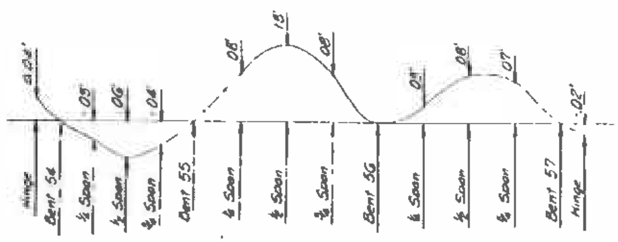
June 23, 1986



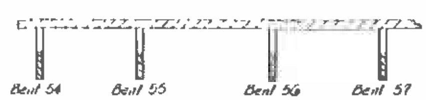
GIRDER LAYOUT
1" = 20'



LONGITUDINAL SECTION
No Scale



CAMBER DIAGRAM
Does not include allowance for falsework settlement



CONCRETE STRENGTH AND TYPE LIMITS

- ☐ Structural Concrete, Bridge (3600 psi)
- ▨ Structural Concrete, Bridge (4000 psi at 28 days)
- ▣ Cast-in-Drilled-Hole Concrete Pile (3600 psi)

PRESTRESSING NOTES

Low Relaxation strand

*P_{jack} = 7900 kips loss in stress = 20,000 psi

Normal Relaxation strand.

*P_{jack} = 8600 kips. loss in stress = 32,000 psi

General

1. Concrete: f'c = 4000 psi @ 28 days.
   f'ci = 3500 psi @ time of stressing
2. Total number of girders = 4
3. Contractor to submit elongation and jacking calculations based on initial stress at ℄ = .81 times jacking stress
4. $A_s = \frac{P_{jack}}{.75 f's}$
*5. Design is based on μ = 0.25 and k = 0.0002 and modified for horizontal curved alignment, if any. P_{jack} specified at the jacking end(s) includes friction losses and provision for loss in stress.
6. Tendons to be jacked to 0.75 f's and anchored at an equivalent anchor set = 5/8"

REDUCED PLAN
USE SCALE BELOW
3 INCHES ON ORIGINAL PLAN

AIRPORT VIADUCT

DESIGN	E. Thorkildsen 6/85	J. Thorne 9/85	State of CALIFORNIA DEPARTMENT OF TRANSPORTATION
DETAILS	J. Inge 6/85	J. Thorne 9/85	
QUANTITIES	T. Nanson 10/85	J. Thorne 10/85	

STRUCTURES - DESIGN 4

BRIDGE NO. 53-2400

POST MILE R15 R20

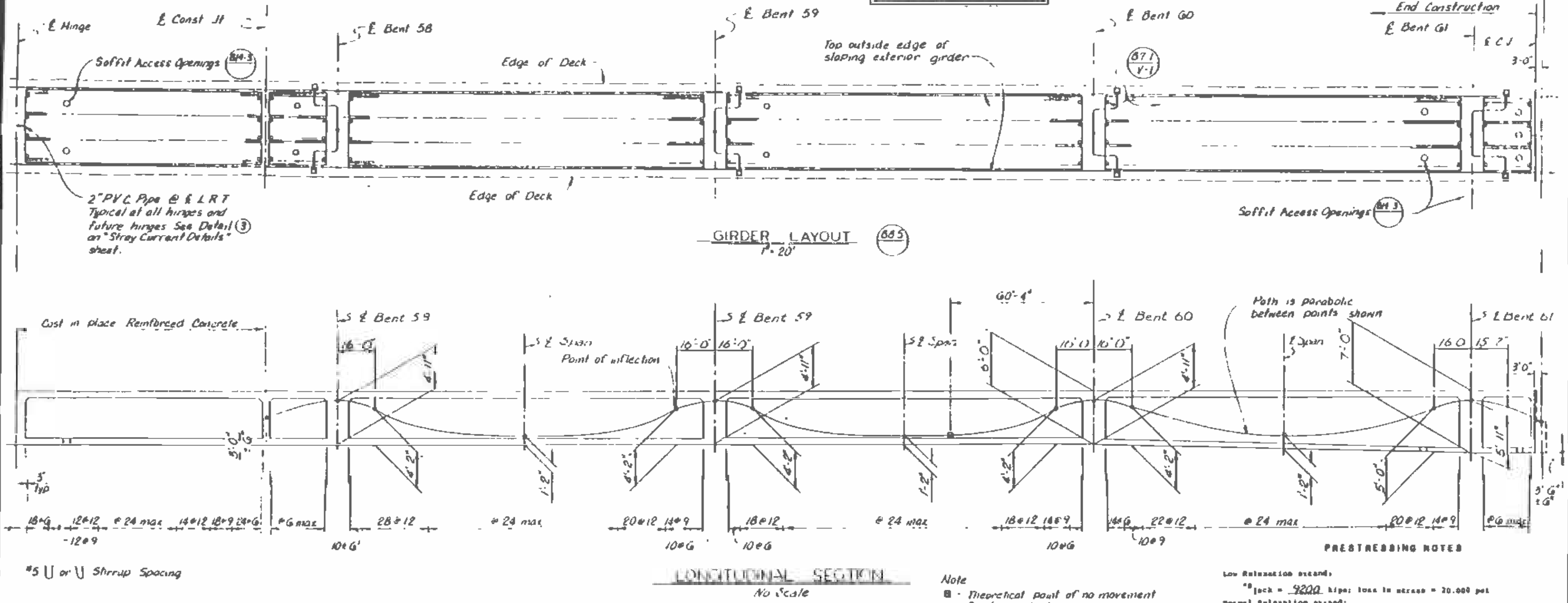
LIGHT RAIL TRANSIT

GIRDER LAYOUT NO. 1

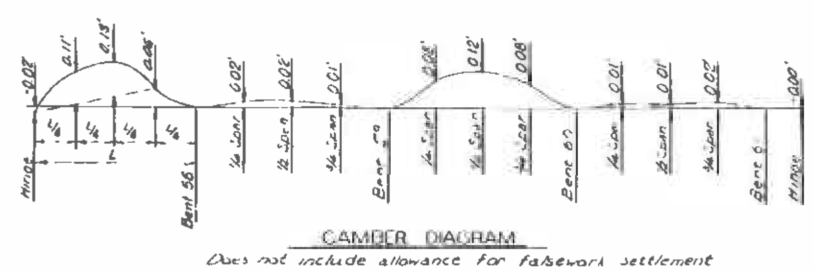
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS

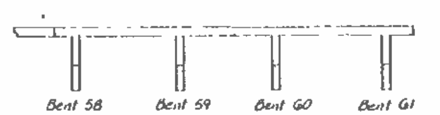
CU 07202

REDUCED PLAN
USE SCALE BELOW



Note
■ - Theoretical point of no movement for two end stressing





CONCRETE STRENGTH AND TYPE LIMITS

- Structural Concrete Bridge (3600 psi)
- Structural Concrete Bridge (4000 psi @ 28 days)
- Cast-in-Drilled-Hole Concrete Pile (3600 psi)

PRESTRESSING NOTES

Low Relaxation strand:
*P jack = 9200 kips; loss in stress = 20,000 psi
Normal Relaxation strand:
*P jack = 9900 kips; loss in stress = 12,000 psi

General:

1. Concrete: f'c = 4000 psi @ 28 days.
   f'ci = 3500 psi @ time of stressing.
2. Total number of girders = 4.
3. Contractor to submit elongation and jacking calculations based on initial stress at ■ = 0.82 times jacking stress
4. $A_s = \frac{P_{jack}}{.75 f's}$
*5. Design is based on μ = 0.25 and k = 0.0002, and modified for horizontal curved alignment, if any
   P jack specified at the jacking end(s) includes friction losses and provision for loss in stress.
6. Tendons to be jacked to 0.75 f's and anchored at an equivalent anchor set = 5/8".

DIST	COUNTY	ROUTE	POST MILES	SHEET	TOTAL
07	LA	105	15/20	243	283

17729
June 23 1986

AIRPORT VIADUCT (PORTION)

LIGHT RAIL TRANSIT

GIRDER LAYOUT NO 2

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

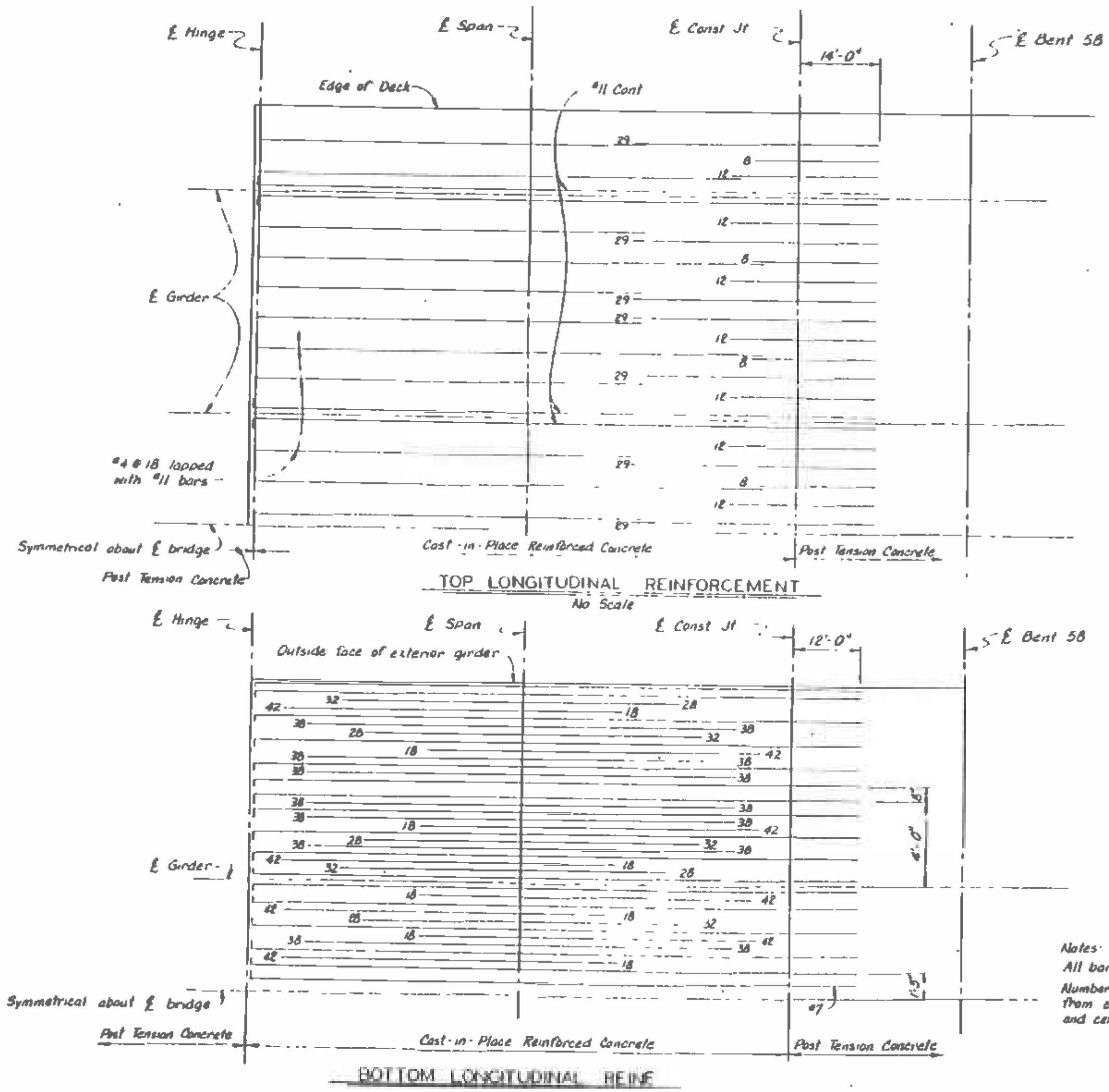
STRUCTURES - DESIGN 4

BRIDGE NO. 53-2400
POST MILE R15-R20

DESIGN Y. Agussa 9/84
DETAILS M. Yanca 9/84
QUANTITIES T. Hanson 1985
J. Thorne 1985

CU 07202
WO 060380W

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS



TOP LONGITUDINAL REINFORCEMENT

No Scale

BOTTOM LONGITUDINAL REINF

Notes:

All bars #11 unless otherwise noted

Numbers at ends of bars indicate distance in feet from centerline of construction joint for top reinforcements and centerline of span for bottom reinforcement

REDUCED PLAN
USE SCALE BELOW

DIST	COUNTY	ROUTE	POST MILE	SHEET	TOTAL
07	LA	105	1.5/2.0	241	283

June 23 1986

DESIGN	M Kipsa	9/84		
DETAILS		9/85		
QUANTITIES	T. Hanson	10/85	J. Thorne	10/85

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4

BRIDGE NO. 53-2400

R15-R20

AIRPORT VIADUCT (PORTION)

LIGHT RAIL TRANSIT

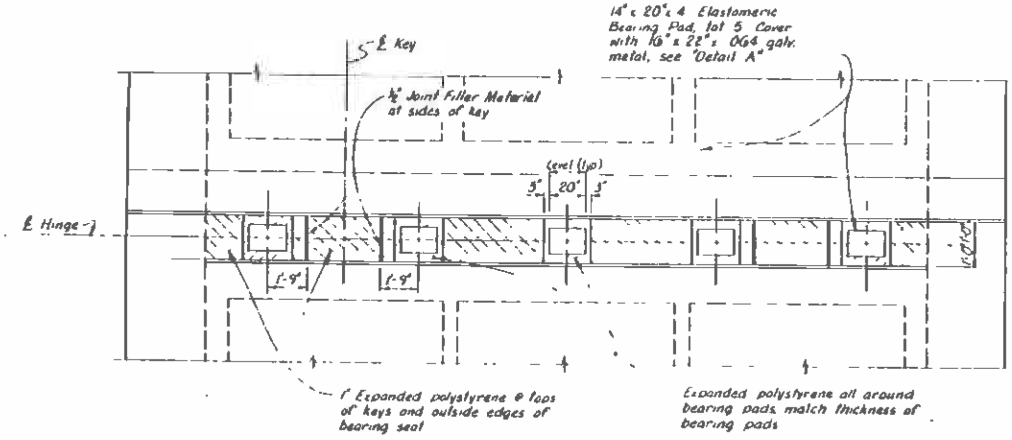
SPAN 57 CLOSURE REINFORCEMENT

241

DIST	COUNTY	ROUTE	POST MILES	SHEET NO.	TOTAL SHEETS
07	LA	105	1.5/2.0	245	283

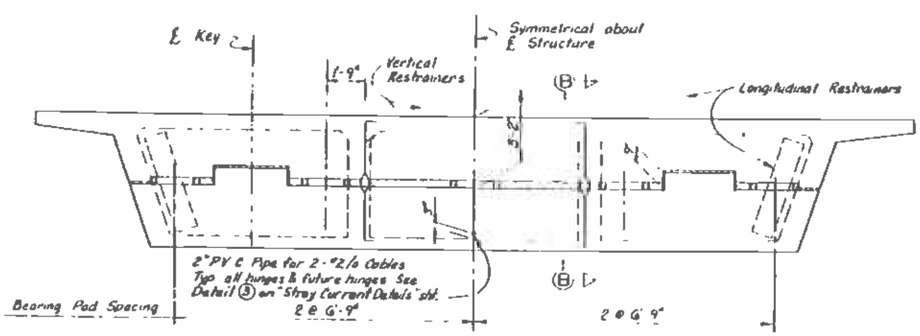
17729

June 23 1986



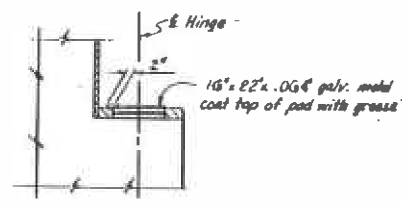
PLAN @ BEARING SEAT - SPAN 57

⅛" = 1'-0"



SECTION @ ℄ HINGE

⅛" = 1'-0"



DETAIL A

No Scale

For Section B-B and other details not shown, see "Hinge Details" sheet

For restrainer details, see "Restrainer/Equalizer Details" sheet

For details not shown, see "Eastbound and Westbound Freeway - Hinge Details" sheet.

Note:
For "Temporary Joint Seal Protection" details, see "EB & WB Freeway" sheet 41 of 60, "Hinge Details" sheet

REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN

DESIGN	M. KOPSA 5/84	9/85
DETAILS	9/85	9/85
QUANTITIES	T. Hanson 10/85	J. Thorne 10/85

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN 4

CE 7845

BRIDGE NO. 55-2400

POST MILE R15-R20

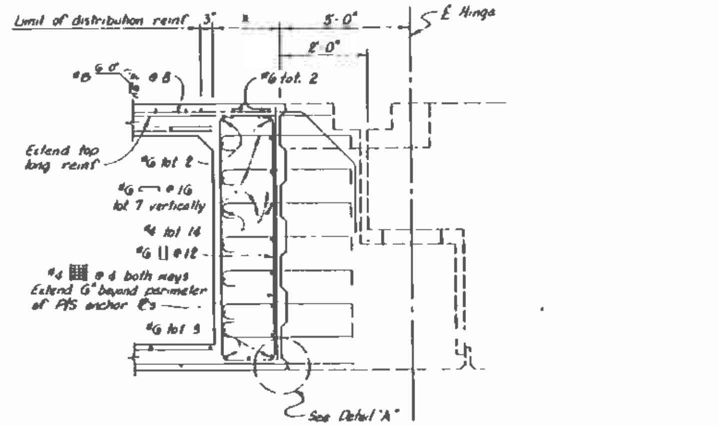
CU 07202
WO 06039W

AIRPORT VIADUCT (PORTION)

LIGHT RAIL TRANSIT

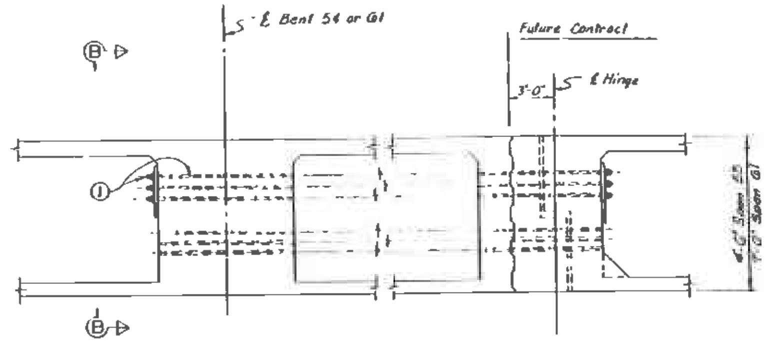
HINGE SPAN 57 DETAILS NO 1

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS

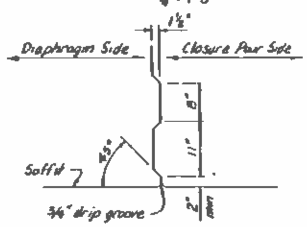


DIAPHRAGM AT HINGE
¼" = 1'-0"

* 1'-6" min to P/S Anchor ℄s

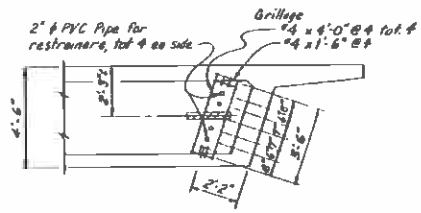


ELEVATION OF LONGITUDINAL HINGE RESTRAINER
(Hinge 61 shown, Hinge 53 is similar, except as noted)

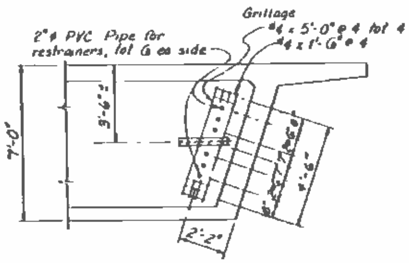


DETAIL "A"
1" = 1'-0"

Note.
Keys may be discontinuous at prestress anchorages.



HINGE SPAN 53

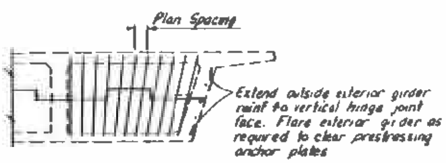


HINGE SPAN 61

SECTION B-B
¼" = 1'-0"

Notes
1. Restrainers and Plate B to be installed during Future Contract construction.

Details shown are for hinge Span 61, details for hinge Span 53 are similar.



PART SECTION @ HINGE SHOWING REINFORCEMENT SPACING IN EXT. BAYS
No Scale

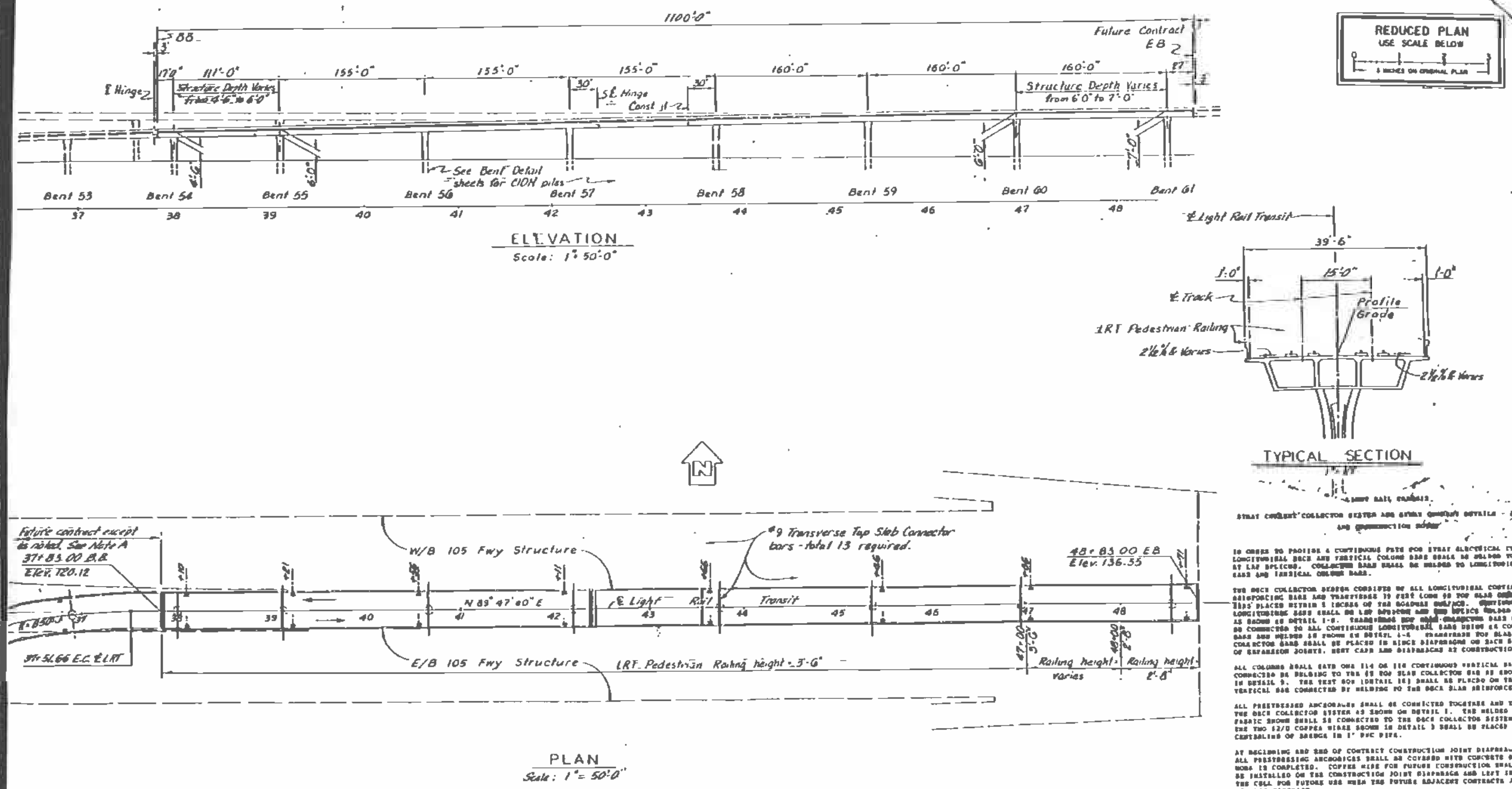
REDUCED PLAN
USE SCALE BELOW

CALIFORNIA
DEPARTMENT OF TRANSPORTATION

AIRPORT VIADUCT

LIGHT RAIL TRANSIT

HINGE SPAN 53 & 61 DETAILS



STRAY CURRENT COLLECTOR SYSTEM AND STRAY CURRENT DETAILS - [illegible] AND CONSTRUCTION [illegible]

IN ORDER TO PROVIDE A CONTINUOUS PATH FOR STRAY ELECTRICAL CURRENT, LONGITUDINAL DECK AND VERTICAL COLUMN BARS SHALL BE WELDED TOGETHER AT LAP SPLICES. COLLECTOR BARS SHALL BE WELDED TO LONGITUDINAL BARS AND VERTICAL COLUMN BARS.

THE DECK COLLECTOR SYSTEM CONSISTS OF ALL LONGITUDINAL CONTINUOUS REINFORCING BARS AND TRANSVERSE [illegible] FEET LONG IN TOP SLAB [illegible] BARS PLACED WITHIN [illegible] INCHES OF THE ROADWAY SURFACE. [illegible] LONGITUDINAL BARS SHALL BE LAP SPLICED AND [illegible] SPLICE WELDED AS SHOWN IN DETAIL [illegible]. TRANSVERSE TOP SLAB COLLECTOR BARS SHALL BE CONNECTED TO ALL CONTINUOUS LONGITUDINAL BARS USING [illegible] CONNECTOR BARS AND WELDED AS SHOWN IN DETAIL [illegible]. TRANSVERSE TOP SLAB COLLECTOR BARS SHALL BE PLACED IN HINGE DIAPHRAGMS ON EACH SIDE OF EXPANSION JOINTS, BENT CAPS AND DIAPHRAGMS AT CONSTRUCTION JOINTS.

ALL COLUMNS SHALL HAVE ONE [illegible] CONTINUOUS VERTICAL BAR CONNECTED BY WELDING TO THE [illegible] TOP SLAB COLLECTOR BAR AS SHOWN IN DETAIL [illegible]. THE TEST BOX (DETAIL [illegible]) SHALL BE PLACED ON THE VERTICAL BAR CONNECTED BY WELDING TO THE DECK SLAB REINFORCEMENT.

ALL PRESTRESSED ANCHORAGES SHALL BE CONNECTED TOGETHER AND TO THE DECK COLLECTOR SYSTEM AS SHOWN ON DETAIL [illegible]. THE WELDED WIRE FABRIC SHOWN SHALL BE CONNECTED TO THE DECK COLLECTOR SYSTEM. THE TWO [illegible] COPPER WIRES SHOWN IN DETAIL [illegible] SHALL BE PLACED AT CENTERLINE OF BRIDGE IN 1" PVC PIPE.

AT BEGINNING AND END OF CONTRACT CONSTRUCTION JOINT DIAPHRAGMS, ALL PRESTRESSING ANCHORAGES SHALL BE COVERED WITH CONCRETE BEFORE WORK IS COMPLETED. COPPER WIRE FOR FUTURE CONSTRUCTION SHALL BE INSTALLED ON THE CONSTRUCTION JOINT DIAPHRAGM AND LEFT IN THE CELL FOR FUTURE USE WHEN THE FUTURE ADJACENT CONTRACTS JOIN TO THIS CONTRACT.

REDUCED PLAN
USE SCALE BELOW
0 1 2 3
INCHES ON ORIGINAL PLAN

07 LA 105

June

AIRPORT VIADUCT PORTION

LIGHT RAIL TRANSIT

STRAY CURRENT COLLECTOR SYSTEM

DESIGN	E G Pomeroy 4/86	H E Mitchell 4/86	
DETAILS	J. Thorne 4/86	H E Mitchell 4/86	
QUANTITIES	T. Hanson 10/85	J. Thorne 9/85	

State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF STRUCTURES
STRUCTURE DESIGN 4
E G Pomeroy 4/86 CE 18465

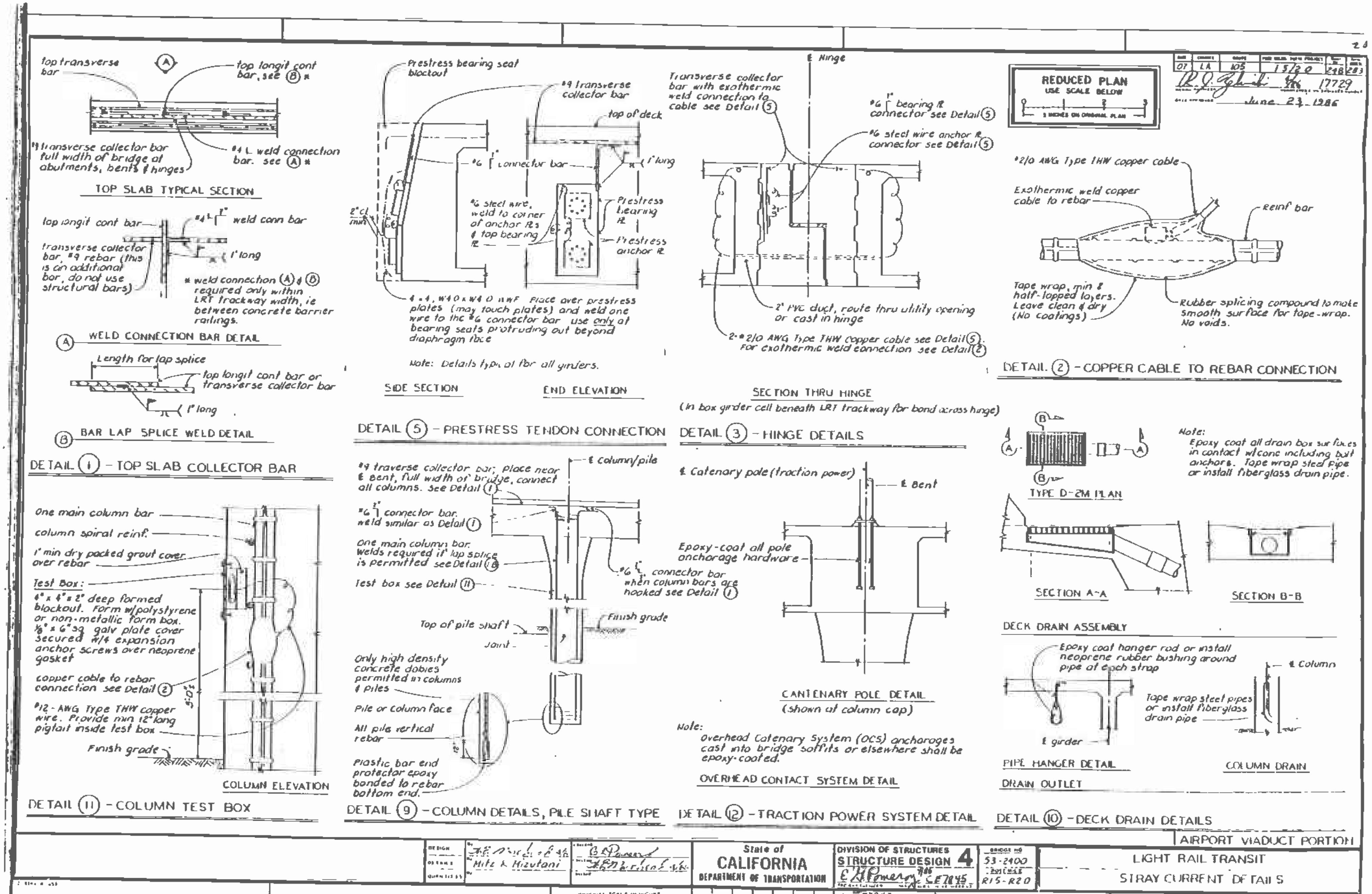
BRIDGE NO. 53-2400
POST MILE R15-R2.0

CU 07202
WO 060394

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS

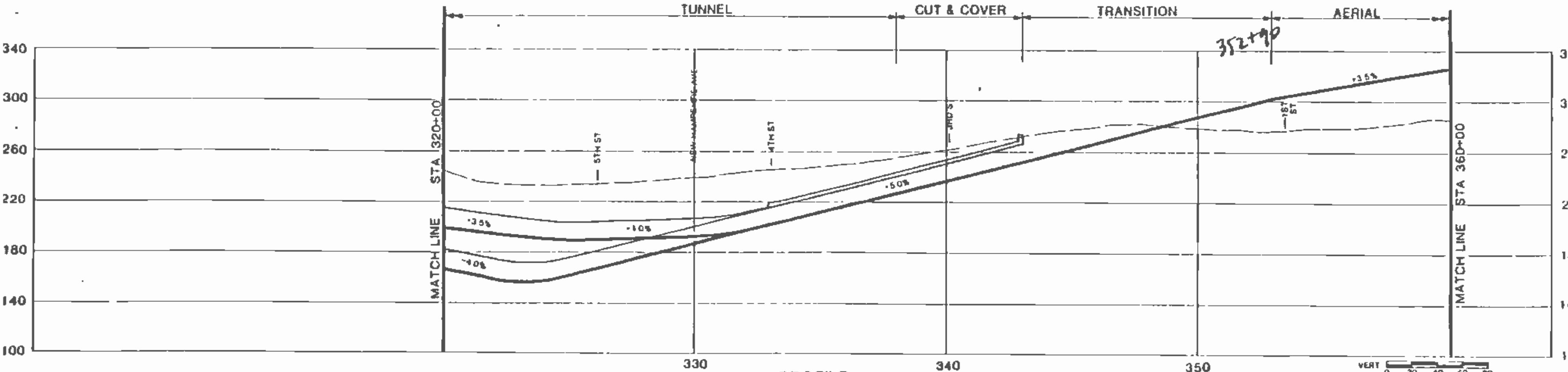
13 | 14

I-105 Century Project 49


top transverse bar
top longit cont bar, see (B) *
#9 transverse collector bar full width of bridge at abutments, bents & hinges
#4 L weld connection bar. see (A) *
TOP SLAB TYPICAL SECTION
top longit cont bar
#4 weld conn bar
transverse collector bar, #9 rebar (this is an additional bar, do not use structural bars)
1" long
* weld connection (A) & (B) required only within LRT trackway width, ie between concrete barrier railings.
(A) WELD CONNECTION BAR DETAIL
Length for lap splice
top longit cont bar or transverse collector bar
1" long
(B) BAR LAP SPLICE WELD DETAIL
DETAIL (1) - TOP SLAB COLLECTOR BAR
Prestress bearing seat blockout
#9 transverse collector bar
top of deck
#6 connector bar
1" long
#6 steel wire, weld to corner of anchor Ⓟs & top bearing Ⓟ
Prestress bearing Ⓟ
Prestress anchor Ⓟ
2" cl min
4 x 4, W4.0 x W4.0 WWF. Place over prestress plates (may touch plates) and weld one wire to the #6 connector bar. Use only at bearing seats protruding out beyond diaphragm face
Note: Details typical for all girders.
SIDE SECTION
END ELEVATION
DETAIL (5) - PRESTRESS TENDON CONNECTION
℄ Hinge
Transverse collector bar with exothermic weld connection to cable see Detail (5)
#6 bearing Ⓟ connector see Detail (5)
#6 steel wire anchor Ⓟ connector see Detail (5)
2" PVC duct, route thru utility opening or cast in hinge
2-#2/0 AWG Type THW copper cable see Detail (5). For exothermic weld connection see Detail (2)
SECTION THRU HINGE
(In box girder cell beneath LRT trackway for bond across hinge)
DETAIL (3) - HINGE DETAILS
REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN
June 23, 1986
17729
#2/0 AWG Type THW copper cable
Exothermic weld copper cable to rebar
Reinf bar
Tape wrap, min 2 half-lapped layers. Leave clean & dry (No coatings)
Rubber splicing compound to make smooth surface for tape-wrap. No voids.
DETAIL (2) - COPPER CABLE TO REBAR CONNECTION
Note: Epoxy coat all drain box surfaces in contact w/conc including bolt anchors. Tape wrap steel pipe or install fiberglass drain pipe.
TYPE D-2M PLAN
SECTION A-A
SECTION B-B
DECK DRAIN ASSEMBLY
Epoxy coat hanger rod or install neoprene rubber bushing around pipe at each strap
℄ Column
Tape wrap steel pipes or install fiberglass drain pipe
℄ girder
PIPE HANGER DETAIL
COLUMN DRAIN
DRAIN OUTLET
DETAIL (10) - DECK DRAIN DETAILS
One main column bar
column spiral reinf.
1" min dry packed grout cover over rebar
Test Box: 4" x 4" x 2" deep formed blockout. Form w/polystyrene or non-metallic form box. 1/8" x 6" sq galv plate cover secured w/4 expansion anchor screws over neoprene gasket
copper cable to rebar connection see Detail (2)
#12-AWG Type THW copper wire. Provide min 12" long pigtail inside test box
Finish grade
5'-0"
COLUMN ELEVATION
DETAIL (11) - COLUMN TEST BOX
#9 traverse collector bar, place near ℄ bent, full width of bridge, connect all columns. See Detail (1)
℄ Column/pile
#6 connector bar, weld similar as Detail (1)
One main column bar. Welds required if lap splice is permitted see Detail (B)
#6 connector bar when column bars are hooked see Detail (1)
Test box see Detail (11)
Top of pile shaft
Finish grade
Joint
Only high density concrete dobies permitted in columns & piles
Pile or Column face
All pile vertical rebar
Plastic bar end protector epoxy bonded to rebar bottom end.
DETAIL (9) - COLUMN DETAILS, PILE SHAFT TYPE
℄ Catenary pole (traction power)
℄ Bent
Epoxy-coat all pole anchorage hardware
CANTENARY POLE DETAIL
(shown at column cap)
Note: Overhead Catenary System (OCS) anchorages cast into bridge soffits or elsewhere shall be epoxy-coated.
OVERHEAD CONTACT SYSTEM DETAIL
DETAIL (12) - TRACTION POWER SYSTEM DETAIL
AIRPORT VIADUCT PORTION
Mitz K. Mizutani
State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF STRUCTURES
STRUCTURE DESIGN 4
CE 7845
53-2400
R15-R20
07202
LIGHT RAIL TRANSIT
STRAY CURRENT DETAILS
07 LA 105 15/20 248 283

APPENDIX E

PLAN



PROFILE

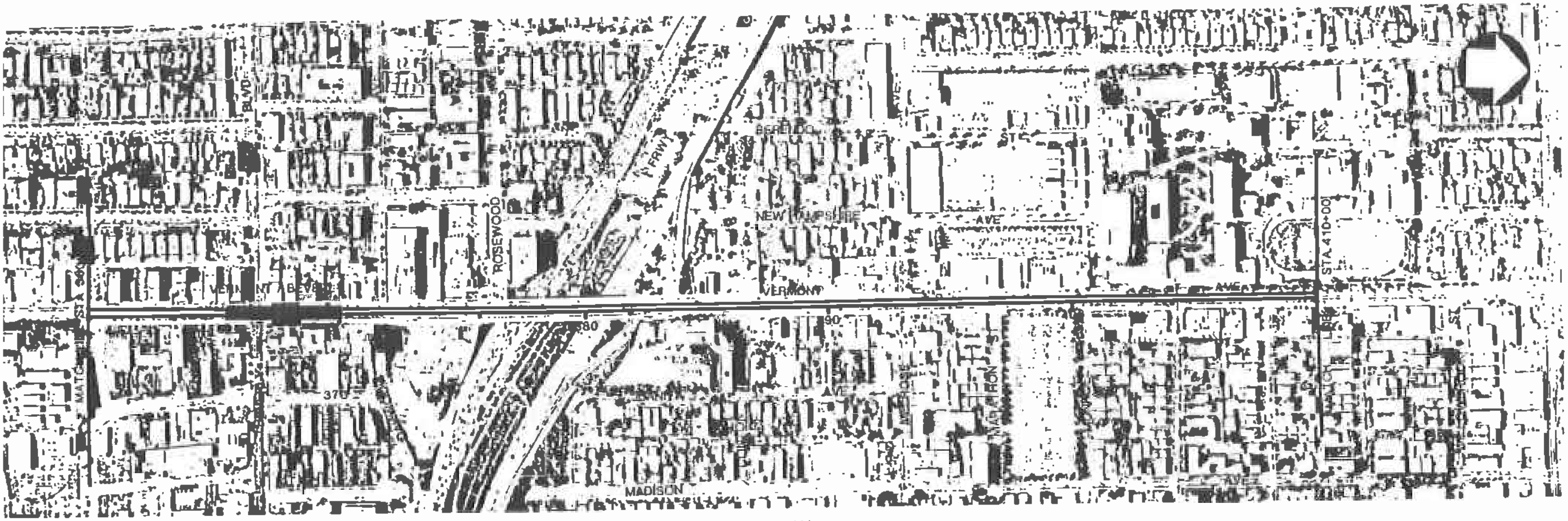
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT
RTD

DMJM/PBQD-KE HWA
GENERAL CONSULTANTS

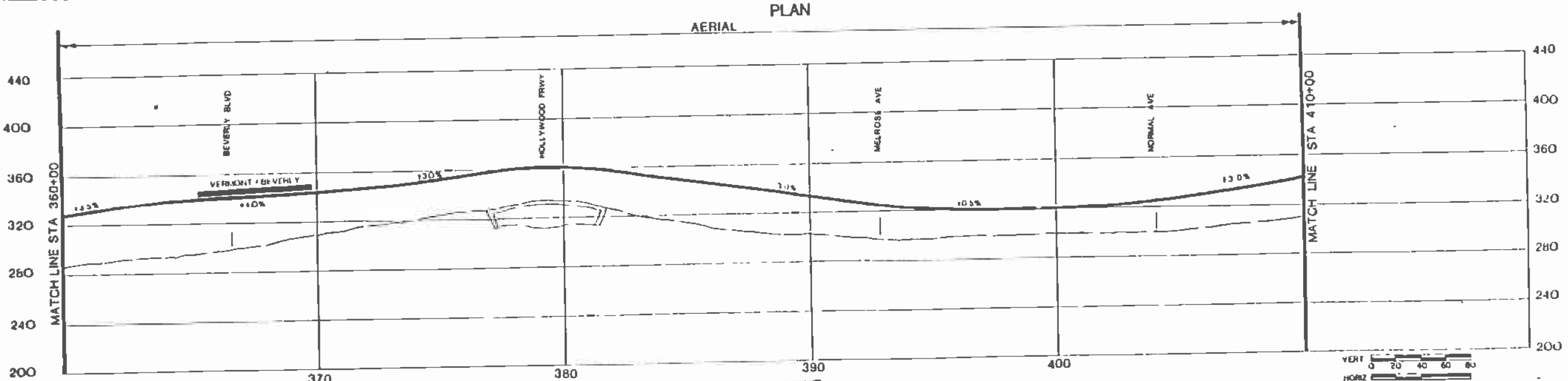
CORE STUDY
CANDIDATE ALIGNMENTS
J & J/A3
PLAN AND PROFILE
STATION 320+00 TO STATION 360+00

SCALE: AS SHOWN
DRAWING NO: 11J
SHEET NO: 71

-11-86



PLAN



PROFILE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

CORE STUDY

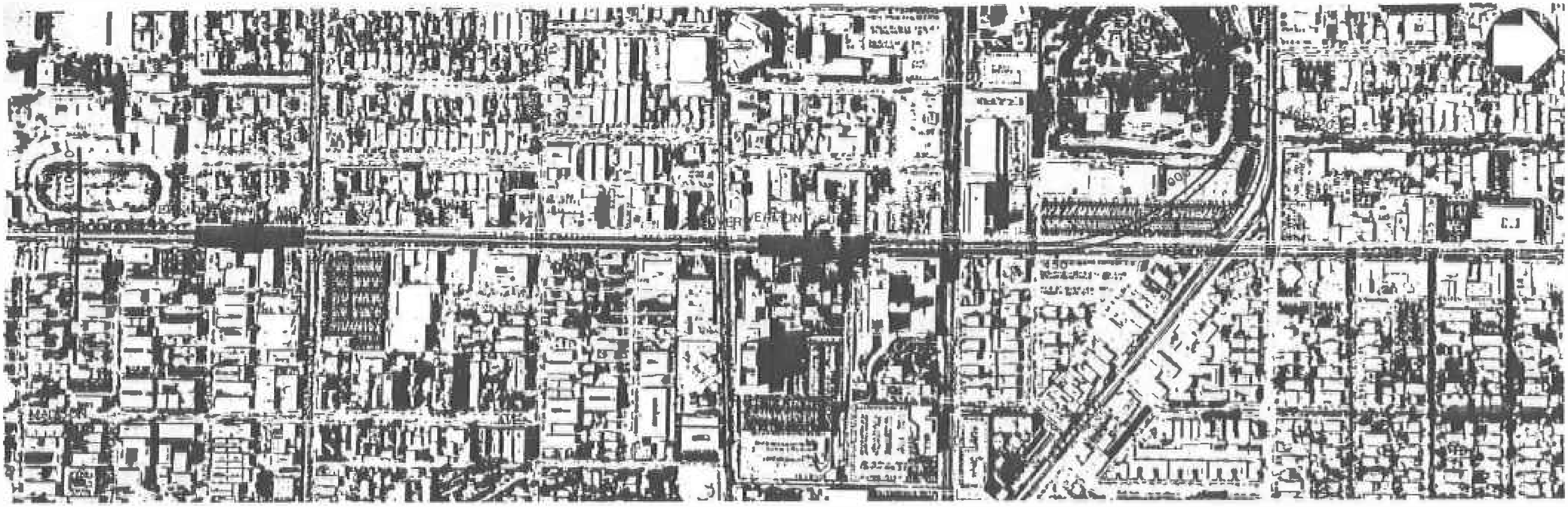
CANDIDATE ALIGNMENTS

J & J/A3

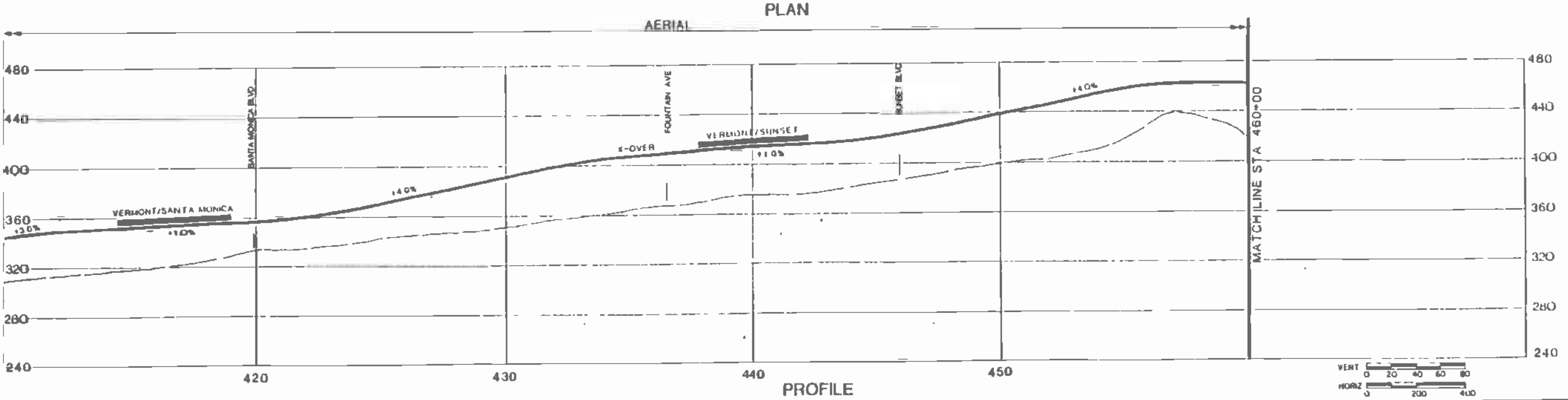
PLAN AND PROFILE

STATION 360+00 TO STATION 410+00

AS SHOWN



PLAN



PROFILE

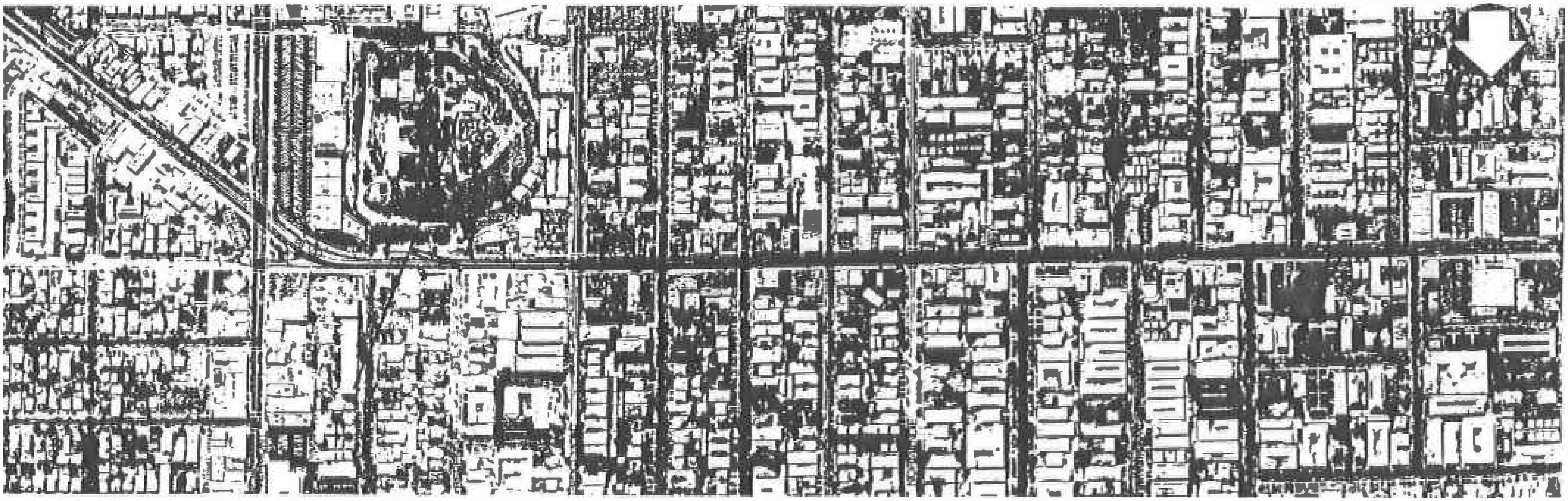
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT
RTD

DMJM PBQD KE/HWA
GENERAL CONSULTANTS

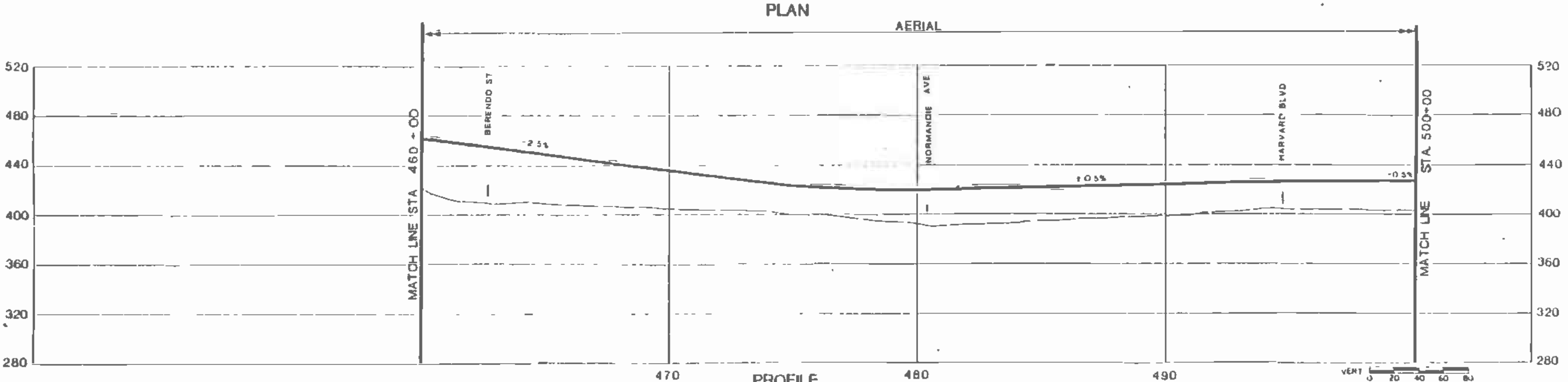
DATE 11-11-86

CORE STUDY
CANDIDATE ALIGNMENT-J
PLAN AND PROFILE
STATION 410+00 TO STATION 460+00

DRAWING NO 32J
SCALE AS SHOWN
SHEET NO 73



PLAN



PROFILE

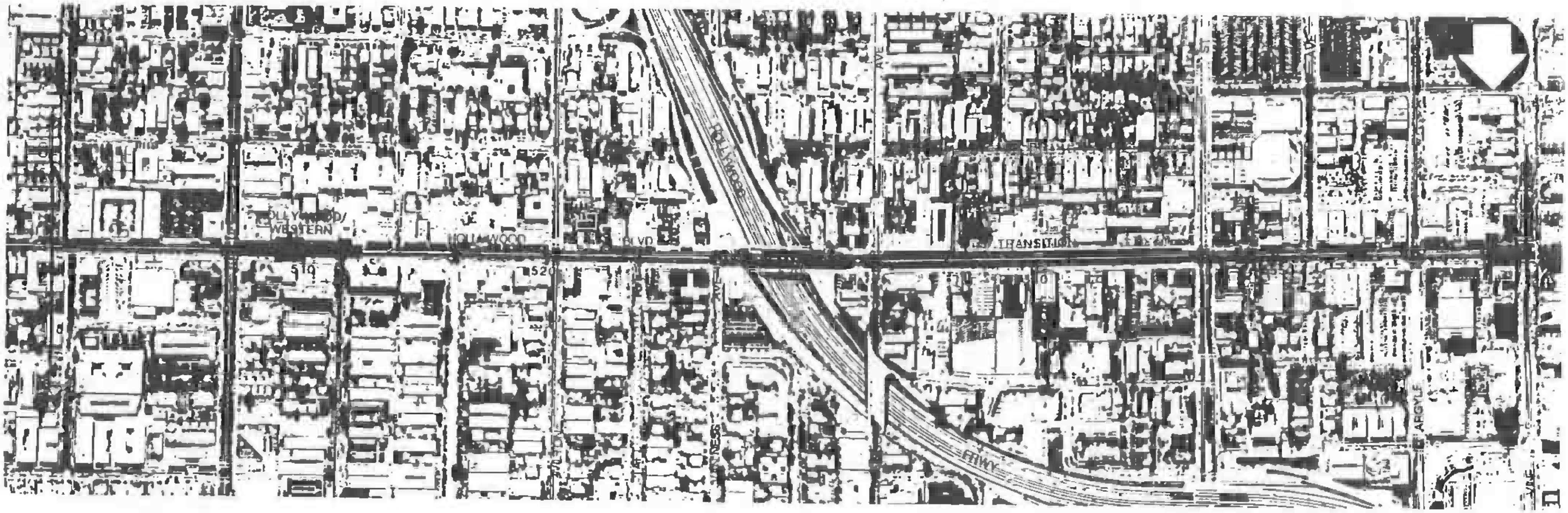
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT
RTD

DMJM PBQD-KE-HWA
GENERAL CONSULTANTS

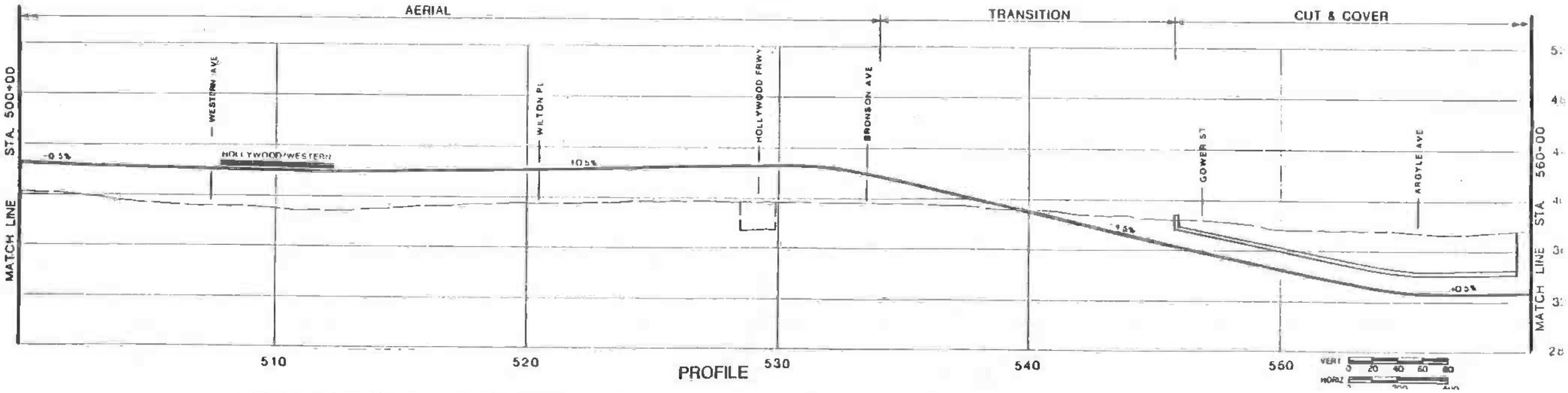
CORE STUDY
CANDIDATE ALIGNMENT-J

PLAN AND PROFILE
STATION 460+00 TO STATION 500+00

DRAWING NO. 33J
SCALE AS SHOWN



PLAN



PROFILE

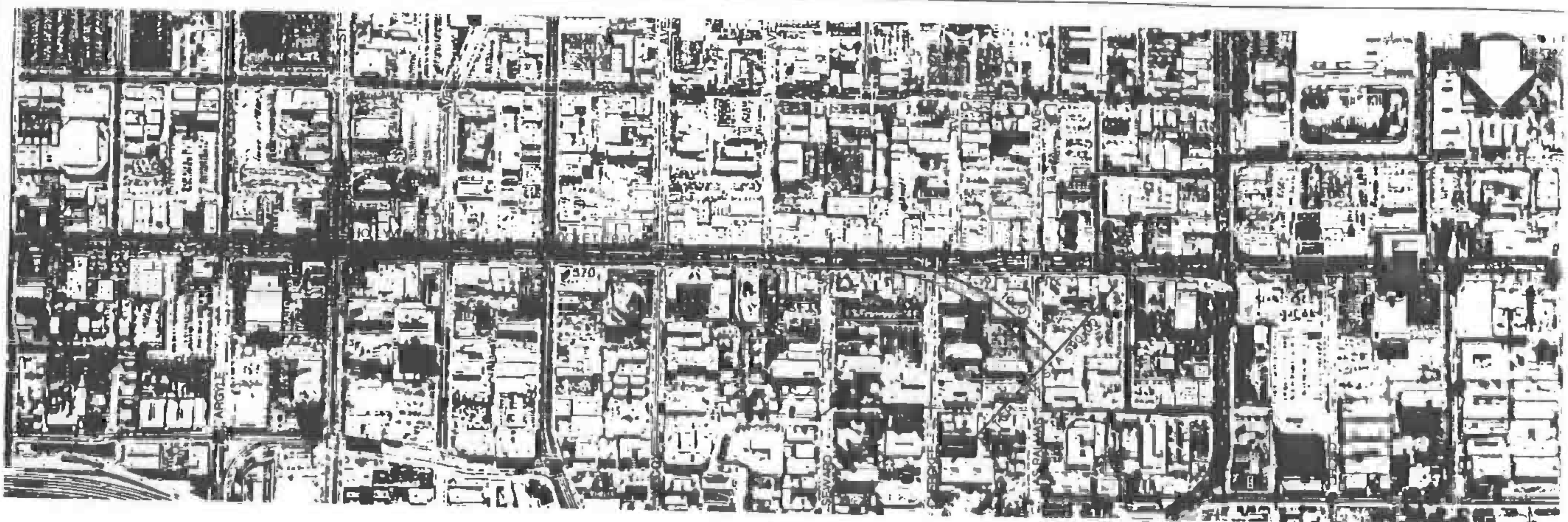
DATE 11-11-86

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

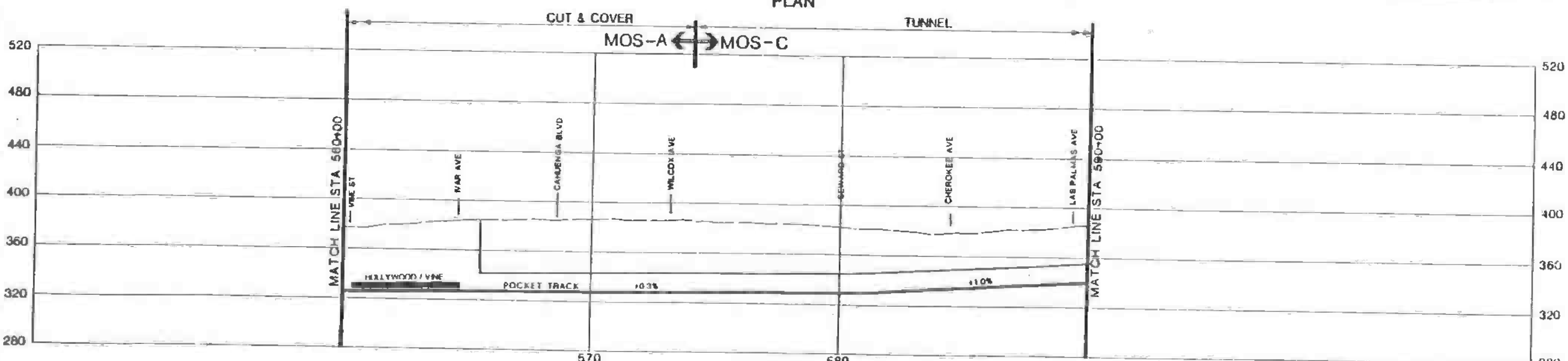
DMJM PBQD KE-NWA

CORE STUDY
CANDIDATE ALIGNMENT-J
PLAN AND PROFILE
STATION 500+00 TO STATION 560+00

DRAWING NO.	34J
SCALE	AS SHOWN
SHEET NO.	75



PLAN



PROFILE

VERT 0 20 40 60 80

HORIZ 0 200 400

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

DMJM PBQD/KE/HWA
GENERAL CONSULTANTS

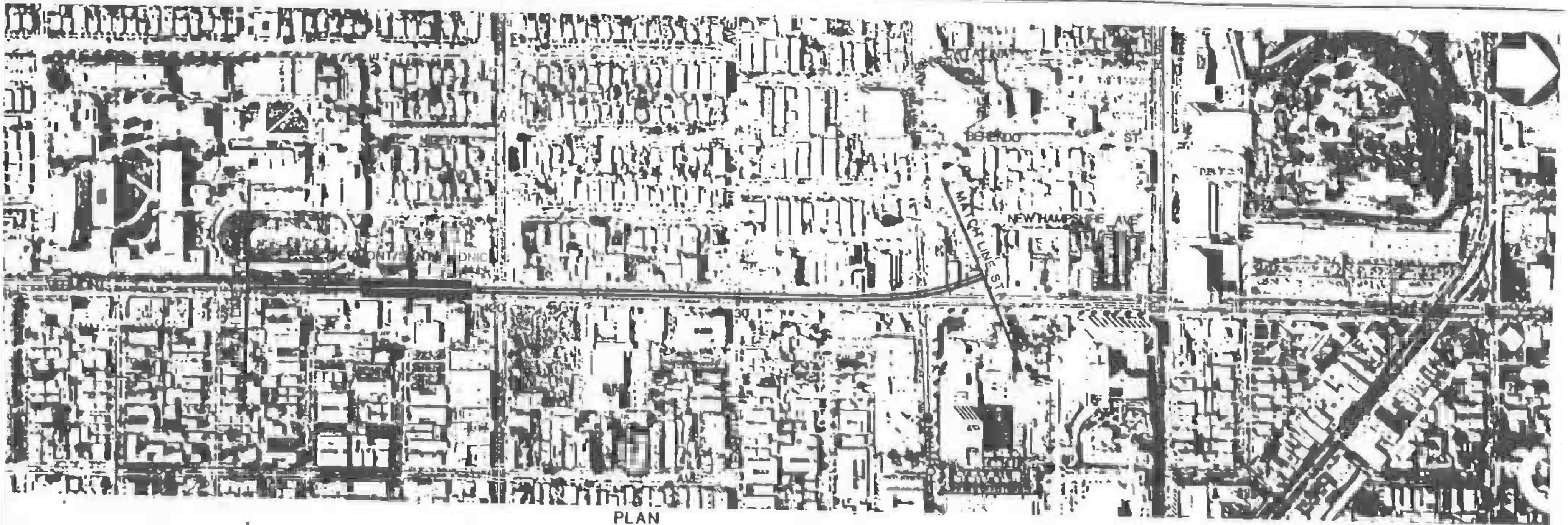
CORE STUDY

CANDIDATE ALIGNMENT-J

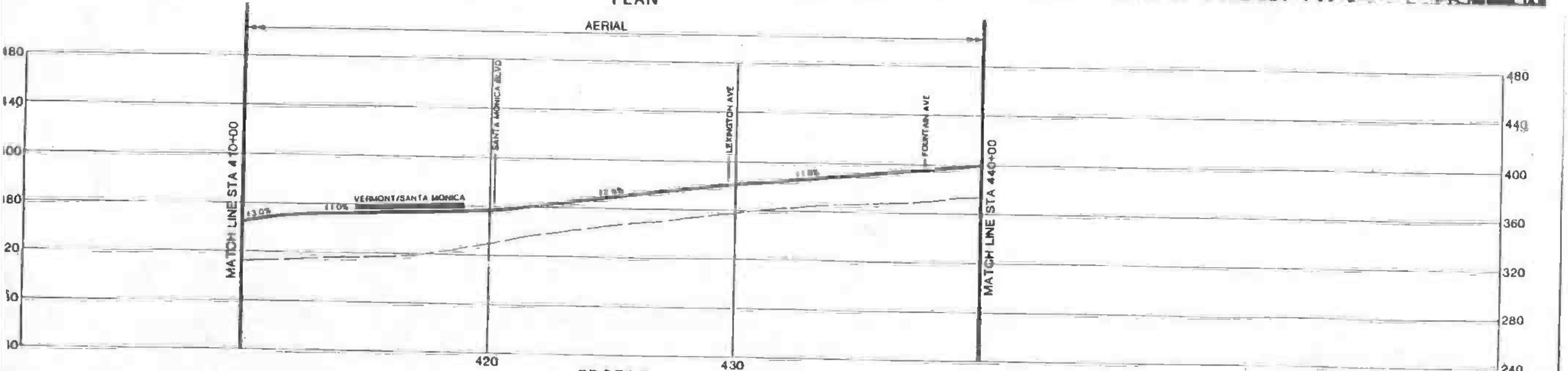
PLAN AND PROFILE

DRAWING NO. 35J

SCALE AS SHOWN



PLAN



PROFILE

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED IN PART THROUGH A GRANT FROM THE U.S. DEPARTMENT OF TRANSPORTATION, URBAN MASS TRANSPORTATION ADMINISTRATION, UNDER THE URBAN MASS TRANSPORTATION ACT OF 1964, AS AMENDED, AND IN PART BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

METRO RAIL PROJECT

RTD

DMJM/PBQD/KE/HWA GENERAL CONSULTANTS

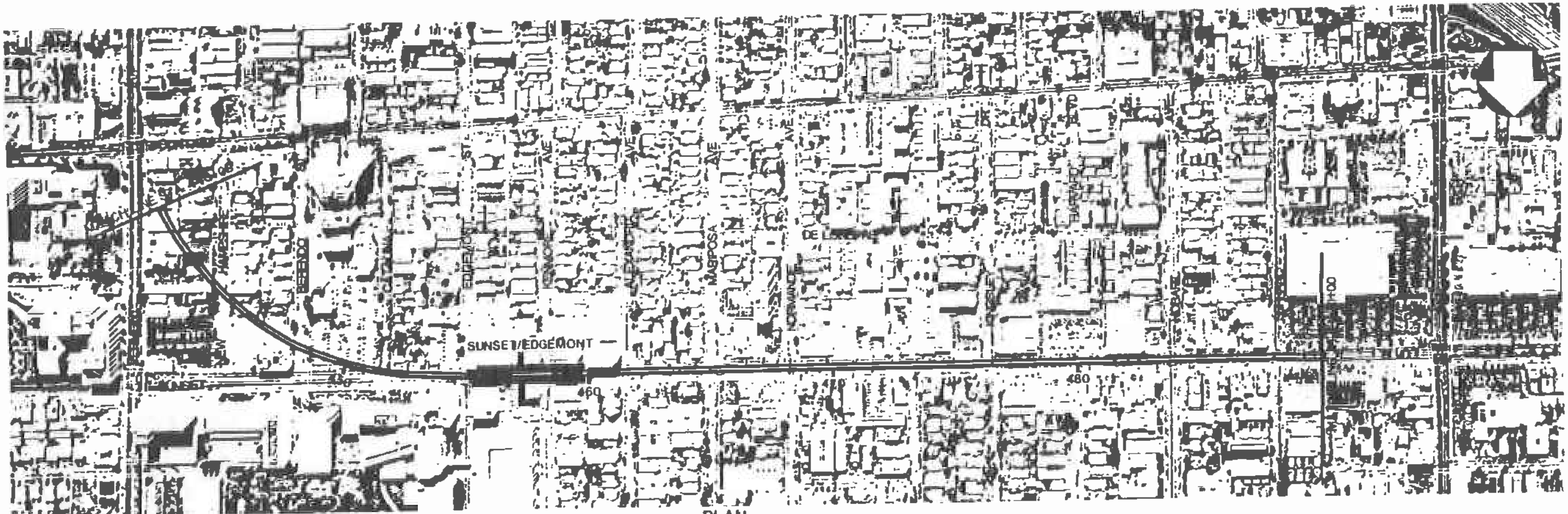
CORE STUDY

CANDIDATE ALIGNMENT J/A3

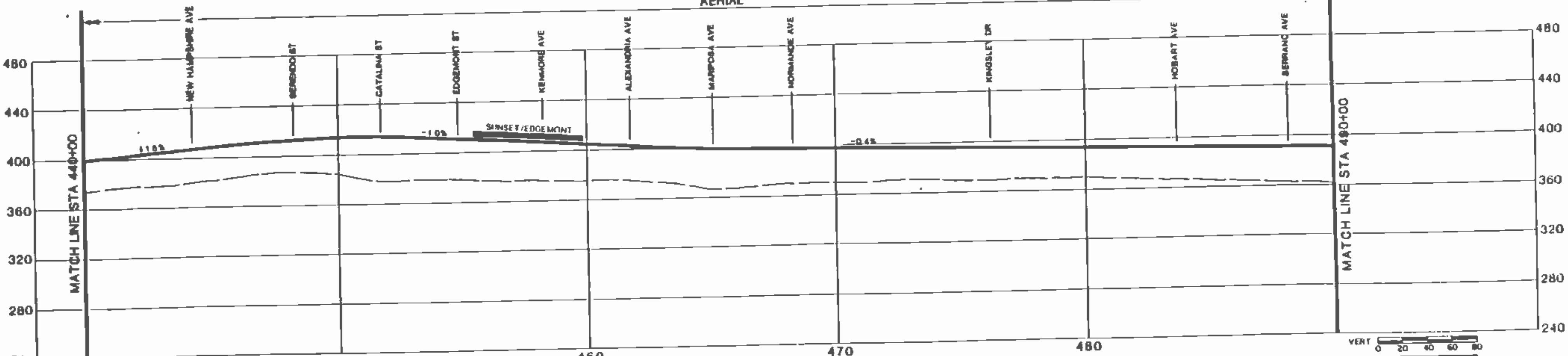
PLAN AND PROFILE

DRAWING NO 12J/A3

SCALE AS SHOWN



PLAN
AERIAL



PROFILE

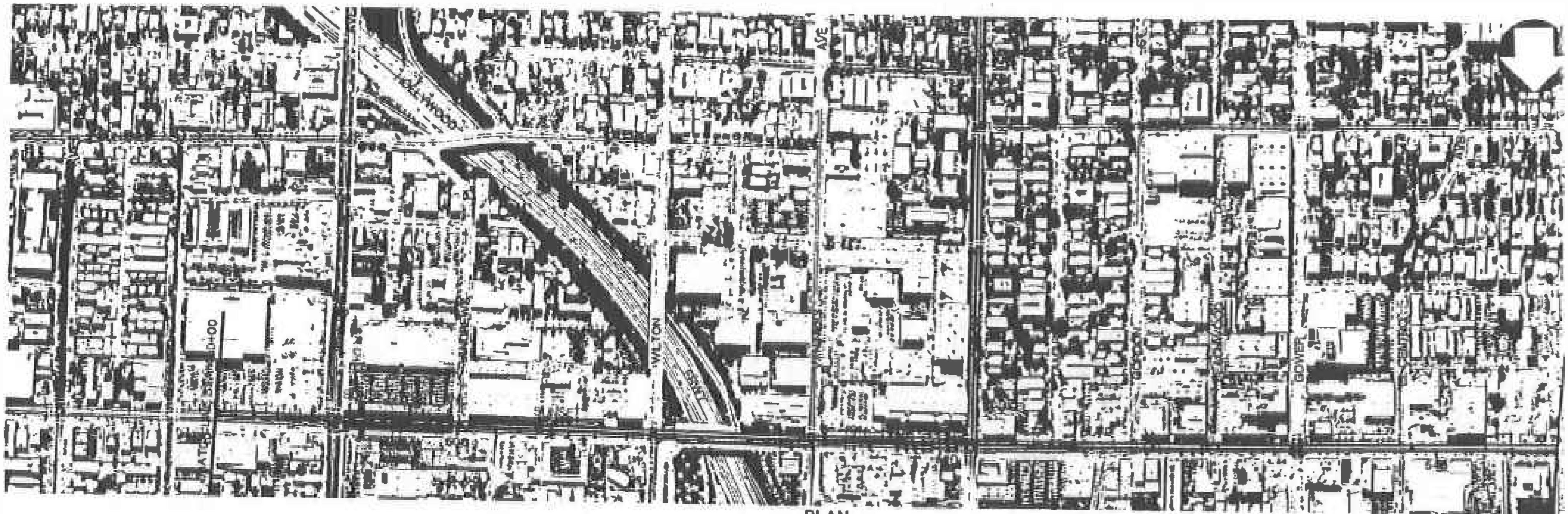
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

DMJM/PBQD/KE/HWA
GENERAL CONSULTANTS

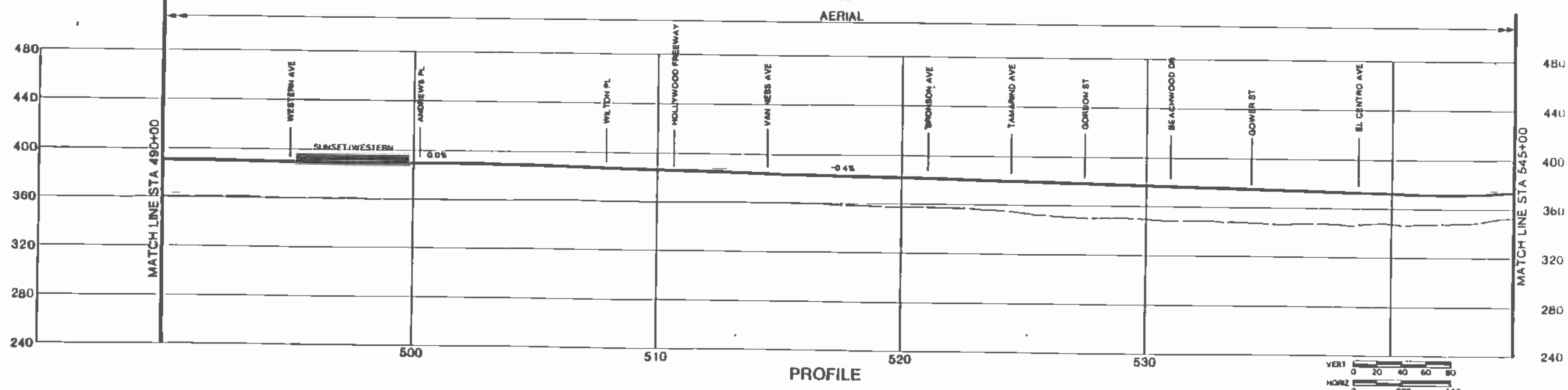
CORE STUDY
CANDIDATE ALIGNMENT J/A3

PLAN AND PROFILE
STATION 440+00 TO STATION 490+00

13J/A3
AS SHOWN
80



PLAN



PROFILE

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED IN PART THROUGH A GRANT FROM THE U. S. DEPARTMENT OF TRANSPORTATION, URBAN MASS TRANSPORTATION ADMINISTRATION, UNDER THE URBAN MASS TRANSPORTATION ACT OF 1964, AS AMENDED, AND IN PART BY THE TAXES OF THE CITIZENS OF

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

METRO RAIL PROJECT

DMJM/PBQD/KE/HWA

GENERAL CONSULTANTS

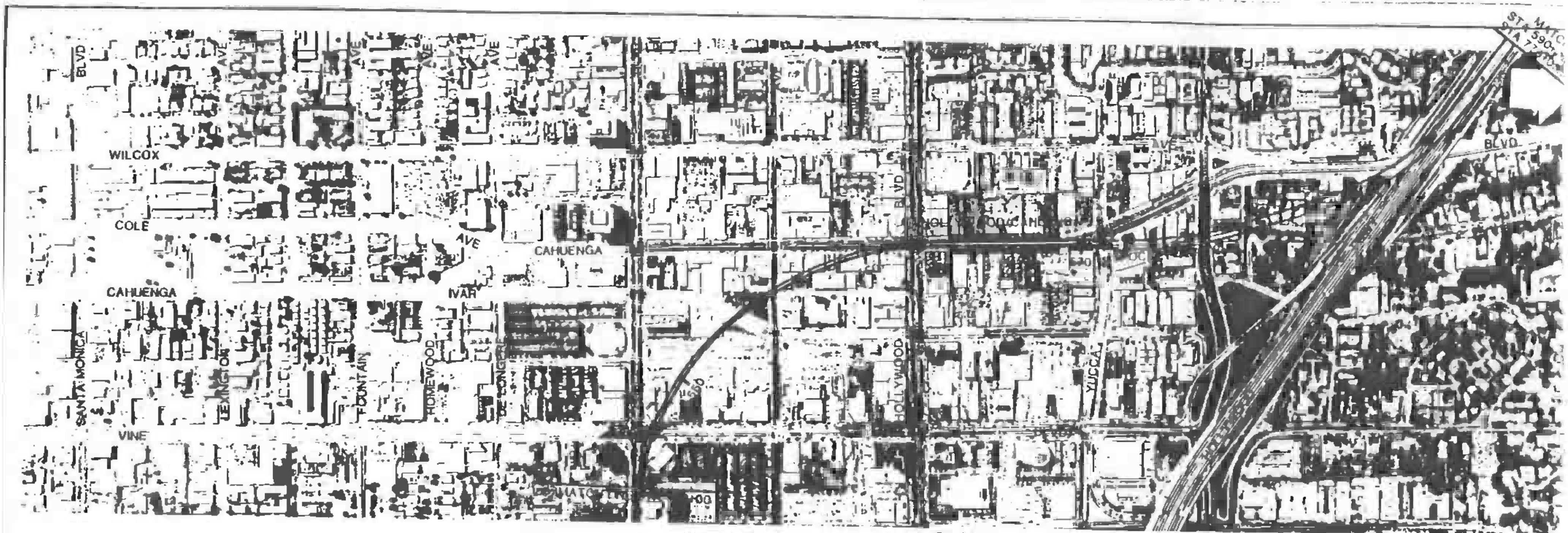
CORE STUDY

CANDIDATE ALIGNMENT J/A3

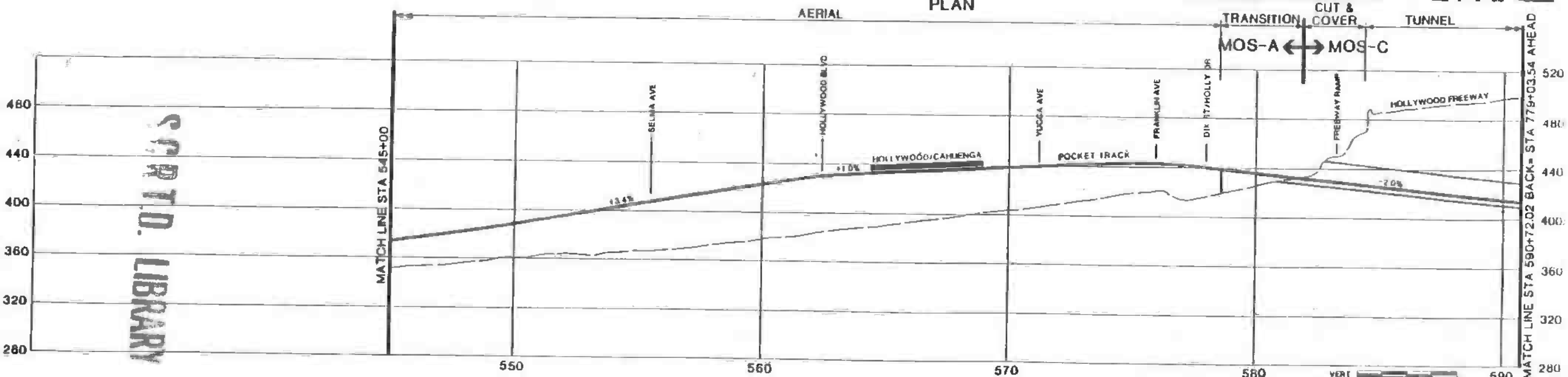
PLAN AND PROFILE

14J/A3

AS SHOWN



PLAN



PROFILE

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
METRO RAIL PROJECT

DMJM/PBQD/KE/HWA
GENERAL CONSULTANTS

11-11-86

CORE STUDY
CANDIDATE ALIGNMENT J/A3
STATION 545+00
TO STATION 590+72.02 BACK=
STATION 779+03.54 AHEAD

15J/A3
AS SHOWN