SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

Structural Condition and Replacement Memorandum

Prepared by:
D. Morales, MSA Design & Consulting

Checked by:
C. Subrizi, MSA Design & Consulting

Reviewed by:
Roupen Donikian, PB

Submitted by:
Gary Kennerley, PB

April 2, 2008

TABLE OF CONTENTS

INTRODUCTION

This structural condition and replacement memorandum was assembled to summarize the reasons why Doyle Drive needs to be replaced and the methodology used to determine the replacement alternatives, from a structural engineering point of view. This document addresses only the structural imperatives that supported selection of the Presidio Parkway as the preferred alternative for a long-term solution to address deterioration of Doyle Drive. The Doyle Drive Final Environmental Impact Statement and Report addresses the full spectrum of environmental, aesthetic and operational considerations that led to a consensus among all participating agencies and the Doyle Drive Citizens Advisory Subcommittee of the San Francisco County Transportation Authority's Citizens Advisory Committee to replace Doyle Drive with the Presidio Parkway. This project has been the subject of a multi-year intensive and extensive engineering and environmental study that included scores of public meetings and opportunities for public participation. The project that has resulted, the Presidio Parkway, is the consensus choice.

Doyle Drive was constructed as part of the Golden Gate Bridge over 70 years ago. The structures in the corridor are, the: Presidio Viaduct (a.k.a. High Viaduct), Marina Viaduct (a.k.a. Low Viaduct) on Doyle Drive; and Ruckman Under Crossing (UC) and Kobbe UC on Veterans Blvd. (a.k.a. Highway 1). These structures are at the end of their useful life and due to their condition, significant structural rehabilitation or replacement is needed. The improvements must be consistent with Doyle Drive's designation as a regional, post-disaster, recovery route.

Interim improvements have been made in order for Doyle Drive to remain in service without restrictions on usage. The most recent example is the interim rehabilitation of the Presidio Viaduct, which is currently underway. This work consists of replacing the failed paint system and providing as-needed replacement of corroded structural support elements. Ten years ago, in the wake of the Loma Prieta earthquake, the structures in the corridor underwent seismic retrofitting. All except the Marina Viaduct were retrofitted to sustain the Maximum Credible Earthquake without collapse. At the Marina Viaduct the expense to achieve this level of seismic performance was determined to be excessive, given that its poor condition state required its replacement in the near term. As a result, a retrofit for a reduced design earthquake was installed assuming that full replacement would be completed within ten years.

A range of long-term improvement options were evaluated under the current Doyle Drive Replacement Project Environmental Impact Studies. Due the Presidio's landmark status, these options included rehabilitation and replacement alternatives. The rehabilitation alternative was withdrawn from further consideration early in the environmental screen process.

To facilitate understanding of the Doyle Drive replacement issues, this document summarizes the structural condition state of Doyle Drive and the evaluation of long term improvement strategies. The primary conclusions emerging from the analysis are:

- Doyle Drive is approaching the end of its design life
- 80% of the Doyle Drive structures cannot be preserved and must be replaced

- Rehabilitation does not address the existing traffic safety deficiencies (no shoulders, narrow lanes, tight curves and limited sight distance)
- Rehabilitation would ultimately cost more than replacement due to maintenance and continued rehabilitation of the facility
- Participating agencies and the Citizens' subcommittee unanimously selected to Presidio Parkway as the Preferred Alternative to replace the facility.
- The Presidio Parkway best meets the project purpose to improve the seismic, structural, and traffic safety of Doyle Drive within the setting and context of the Presidio of San Francisco and its purpose as a National Park.

1.0 SUMMARY OF STRUCTURAL CONDITION STATE OF DOYLE DRIVE

Why must Doyle Drive be replaced if the Golden Gate Bridge does not?

This is a reasonable question considering the fact that the structures were built around the same time. However, to answer this question the significant difference in condition due to the level of maintenance and rehabilitation undertaken to date must be considered. Today, over 70 years since completion, the Structural Evaluation of the Golden Gate Bridge (GGB) characterizes it as “superior to the present desirable criteria,” while Doyle Drive just “meets the minimum tolerable limits to be left in place as is.” As a result, despite its outdated roadway geometry, the Sufficiency Rating of the GGB is a relatively high ***58.9.*** Maintenance of this rating has required the replacement of many of the GGB structural components, a task that is ongoing.

1.1 Sufficiency Rating of Doyle Drive Structures

The sufficiency rating (SR), the standard structural condition indicator used by FHWA, is a general indicator that accounts for many variables, including: structural adequacy, load carrying ability, serviceability, functional adequacy and importance to the public transportation network and the national defense network. Though made up of these many variables the SR is dominated by structural condition. The SR is a numeric value indicative of bridges’ sufficiency to remain in service. It ranges from 0 - insufficient, to 100 - sufficient. The SR is the sum of 4 variables and each variable is made up of several components. The SR does not include any consideration of seismic safety or performance. Table-1 and Table-2 summarize the SR variables and associated components for the major Doyle Drive structures. 88% of the deck area has an SR < 35, which is 30% lower than the FHWA replacement funding threshold, see Appendix A. Note that special reduction, S_4 does not apply to the Doyle Drive Structures.

$$SR = S_1 + S_2 + S_3 - S_4$$

Table 1. Sufficiency Rating

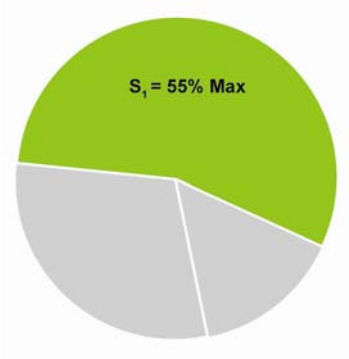
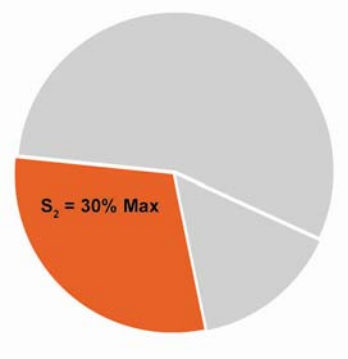
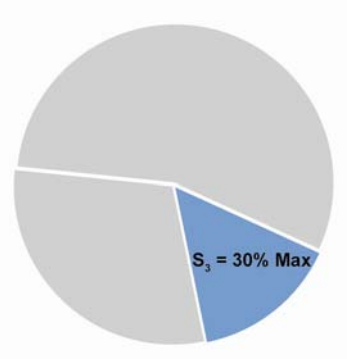
Structural Adequacy and Safety S_1	Serviceability and Functional Obsolescence S_2	Essentiality for Public Use S_3
		
Inventory Rating (IR) Superstructure Rating Substructure Rating	Deck Condition, Structural Evaluation, IR Deck Geometry, Under-clearances, Approach Road Alignment, Lanes on Structure, Average Daily Traffic, Bridge Roadway Width, Structure Type, Vertical Clearances, STRAHNET (Strategic Highway Network) Designation	Roadway Lengths, Average Daily Traffic, STRAHNET (Strategic Highway Network) Designation

Table 2. Sufficiency Rating Components

Structure	SR Overall Sufficiency Rating	S_1 Structural Adequacy and Safety	S_2 Serviceability and Functional Obsolescence	S_3 Essentiality for Public Use	Condition Status
Presidio Viaduct	2.0%	0.0%	2.0%	0%	Structurally Deficient Functionally Obsolete
Marina Viaduct	24.4%	22.4%	2.0%	0%	Structurally Deficient Functionally Obsolete
Ruckman UC	31.3%	29.3%	2.0%	0%	Structurally Deficient Functionally Obsolete
Kobbe UC	58.3%	54.3%	4.0%	0%	Structurally Deficient Functionally Obsolete

1.1.1 Time to Replace

Today, these structures are 3 years shy of the 75-year target design life, as designated in the national bridge design code. The level of maintenance of the GGB is such that its life will be extended beyond this milestone.

In contrast, the Doyle Drive structures have reached the end of their useful life. Each has a "to do list" or action items requiring completion to ensure survival in the immediate future, without imposing vehicle weigh restrictions, while maintaining a tolerable risk exposure to extreme events such as earthquakes and extreme wind.

The works of antiquity that have survived millennia are often mistakenly used as a point of reference when the subject of design life is broached. Unlike those, the structures that make up Doyle Drive must sustain repeated tensile stresses from vehicles and from temperature changes. It is this daily chore that eventually wears out these bridges.

Current technology is not able to predict the exact time of ultimate failure, so as we approach the design life, monitoring increases and replacement of primary structural elements follows soon after. Depending on the type of bridge, replacement could take place component by component or in its entirety.

The GGB replacement of the Marin Approach underwent not only deck and truss plate replacement but full pier replacement as well. Additionally, the anchorage housings, which have deck systems and pier supports similar to the Marina Viaduct, but which are hidden from view by curtain walls, will undergo complete 'T' girder deck replacement as well as a complete encapsulation of the pier supports in reinforced concrete. Unfortunately, this strategy cannot be employed at Marina since it is in full view of the public and aesthetics are an important concern. Ultimately, Doyle Drive does not enjoy the same relatively consistent financial support as the GGB, nor is it dominated by a structure type that is amenable to component by component replacement, namely the GGB main-span. Unless these realities change it is unreasonable to expect Doyle to function effectively much after the design life.

Table-3 provides a condition status overview that includes a chronology of recent upgrades and the backlog "to do list". Section 3.0 contains graphical fact sheets for each major structure summarizing bridge condition and locations of concern.

1.1.2 Presidio Viaduct

Caltrans initiated plans to replace this structure in 1993 (see correspondence in Appendix B) recognizing that a rehabilitation plan, keeping pace with the Golden Gate Bridge could not be sustained from the limited and highly competitive freeway funding pool. Furthermore, due to the lower original design load the SR would barely exceed 35, even after completing a full rehabilitation. In real terms, the low SR restricts growth in future truck and bus volumes. Moreover, given the importance of the GGB, Doyle Drive is designated as a Post Disaster Recovery Route. Despite a relatively recent seismic retrofit in 1998, the current level of deterioration has reduced the reliability of the corridor to perform this function.

As shown in Table 3, the "to do list" has increased in the last 15 years. After the current interim paint and rehabilitation project has been completed, engineering studies can be

initiated to determine the impact of section loss on seismic safety. These studies will also provide a clearer understanding of the impact of section loss should deck replacement become necessary. Deck replacement could be required if the Doyle Drive Replacement Project undergoes further delay. Given the current project development schedule, it appears that reactive management of the "to do list" items is to be expected since the elements in question are at the end of their useful life.

1.1.3 Marina Viaduct

Caltrans initiated plans to replace this structure in 1993 after seismic retrofit strategy development revealed that the conventional retrofit for the Maximum Credible Earthquake (MCE) would cost near the replacement value. Moreover, a deck replacement, including barrier and lighting standards would still be required. Given that the deck is made up of integral reinforced concrete "T" beams, replacement equates to entire superstructure replacement. Substructure improvement can be made by an encapsulation, which replaces the functions of the original construction. This strategy, which was employed at the GGB Anchorage Housing, is likely to require that infill walls be installed between columns, creating a change in the look of the structure and restricting views. Alternately the entire substructure can be replaced in a form that is open, similar to what we see today. Given that the completion date of the Doyle Drive Replacement Project development was uncertain in 1993, Caltrans initiated an Interim Retrofit, for a lower than maximum expected seismic demand with an intended design life of 10 years. The construction of this retrofit was completed in 1998. Today, about 10 years later, the structure remains in place. Caltrans will likely have to implement further interim mitigation.

1.1.4 Highway-1 Bridges

Ruckman Under Crossing

This long viaduct was seismically retrofitted in 1995. The deterioration rate of its deck has increased in the last 10 years. Like Marina and Kobbe this bridge is an integral "T" type. Deck life can be prolonged somewhat with deck sealing, joint sealing and an overlay. Maintenance will need core samples to provide a clearer prognosis. Complete deck replacement would require a new substructure, which occurred at the GGB Anchorage Housing. Given that the structure has a SR less than 35, it is continuing to deteriorate and requires major improvements, replacement of this structure is a necessary part of the Doyle Drive Project.

Kobbe Undercrossing

This long viaduct was seismically retrofitted in 1995 and although it possesses elements that are in better shape than Ruckman UC, its deck deterioration rate has increased in the last 10 years. Like Ruckman and Marina this bridge is an integral "T" type. Deck life can be prolonged somewhat with deal sealing, joint sealing and an overlay. Maintenance will need core samples to provide a clearer prognosis. Complete deck replacement, which occurred at the GGB Anchorage Housing, would require a new substructure. This structure is not currently programmed for replacement however, given the deck condition state, interim rehabilitation of the deck and joints is anticipated. It is judged likely that replacement will be necessary in the near future and would ideally be programmed concurrent with the Doyle Drive Project.

Table 3. Condition Status Overview

Structure	Golden Gate Bridge	Presidio Viaduct	Marina Viaduct	Park Presidio Interchange	HWY 1 Bridges
Completion Year	1937	1936	1936	1939	1939
Maintenance Funding Source	Tolls & Competitive Freeway Funding Pool	Competitive Freeway Funding Pool	Competitive Freeway Funding Pool	Competitive Freeway Funding Pool	Competitive Freeway Funding Pool
Structural Evaluation	Superior to present desirable criteria	Meets minimum tolerable limits to be left in place as is	Meets minimum tolerable limits to be left in place as is	Meets minimum tolerable limits to be left in place as is	Meets minimum tolerable limits to be left in place as is
Seismic Performance	Extensive Damage Risk Main Span at risk until Phase III retrofit completion	Extensive Damage Risk Major section loss in Truss noted during ongoing paint rehab will require a seismic vulnerability evaluation and retrofit strategy development	Extensive Damage Risk Intolerable requiring a high priority of replacement Interim retrofit was a tolerable risk for 10 year life (1998 -2008)	Moderate Damage Risk Simple low risk structures that are significantly deteriorated	Moderate Damage Risk Simple low risk structures that are significantly deteriorated
Improvements As of Feb 2008	1953-54 Added Wind Bracing 1973-76 Replaced Suspender Ropes 1982-86 Deck and Stringer Replacement 1993-94 Railing Replacement 1997 – 2002 Phase I Seismic Retrofit 2001 – Present Phase II Seismic Retrofit	1939 Widening 1979 Deck drain repair and truss spot repair 1983 Seismic Restrainers 1998 Seismic Retrofit 2006 – Present Paint Rehab, Spot Truss Repair, Joint Seal	1983 Seismic Restrainers 1992 Overlay and Joint Seal 1998 Interim Seismic Retrofit	1955 Widening 1983 Seismic Restrainers 1994 Joint Seal 1998 Seismic Retrofit	1983 Seismic Restrainers 1995 Joint Seal & Seismic Retrofit
"To do list" As of Feb 2008	2008 Complete Phase II Seismic Retrofit 2008 Begin Phase III Seismic Retrofit	Year TBD Complete Replacement Interim Deck Replacement Year TBD Railing & Light Standard Replacement Year TBD Seismic Re-Assessment to account for truss deterioration Year TBD Seismic Retrofit of Truss	Year TBD Complete Seismic Retrofit by Full Replacement Year TBD Interim Deck Sealing Year TBD Interim Railing & Light Standard Replacement	Year TBD Complete Replacement Interim Deck Sealing, Core Sampling & Material Testing Year TBD Interim Railing & Light Standard Replacement	Year TBD Complete Replacement Year TBD Interim Deck Sealing, Core Sampling & Material Testing Year TBD Interim Railing & Light Standard Replacement

TBD = To Be Determined

2.0 Why Doyle Drive Must be Replaced and Cannot Feasibly Be Preserved via Rehabilitation

The Presidio and Marina Viaducts are designated as historic properties and contribute to the National Historic Landmark District of the Presidio of San Francisco; as a result, long-term rehabilitation and replacement alternatives were evaluated. Viability of rehabilitation is dependent on the current condition of the structure. The following section describes the evaluation of improvement strategies for structures in the corridor which determined that rehabilitation is not a viable option and the structures require replacement.

2.1 Current Condition

Condition state, as summarized in the first section of this memorandum, is described using the FHWA standard Structure Inventory and Appraisal guide which uses the Sufficiency Rating (SR) condition indicator. The SR is a general indicator that accounts for many variables, including: structural adequacy, load carrying ability, serviceability, functional adequacy and importance to the public transportation network & the national defense network. Though made up of these many variables the SR is dominated by structural condition.

In spite of the long history of earthquake engineering, standardization of seismic assessment procedures is only recently achieving national acceptance. As a result the SR does not yet include any information on seismic safety. As earthquake engineering has advanced, the FWHA relied on local jurisdictions to assess seismic safety. In that regard Caltrans retrofit contract plans and strategy memoranda were consulted.

Given the unique history of Doyle Drive and its role as the South Approach to the Golden Gate Bridge, the condition state is presented in the context of the greater Golden Gate Bridge (GGB) facility. This context was also the starting point in evaluating potential rehabilitation oriented improvement strategies.

2.2 Improvement Strategies Evaluated that Confirm the Need to Replace Doyle Drive

The purpose of the Doyle Drive replacement project is to rectify the current deficiencies in structural safety (including seismic design) and driver safety, while minimally impacting the surrounding natural and cultural resources. Three alternatives are considered: Rehabilitation, Replace and Widen, and complete replacement of the current viaducts with the Presidio Parkway.

2.2.1 Why the Rehabilitation Strategy Is Not Feasible

Preserving Doyle Drive would consist of two component strategies, which are:

1. Extend the life of the structure beyond the useful life of its most heavily worn original parts by replacing components of the bridge over time while preserving the original “look and feel.”

2. Replace the structure because certain structure types preclude reliable and cost effective component replacement. The structure would be the entire bridge or large segments of the bridge. The “look and feel” would resemble the original, resulting in a replacement “in-kind.”

In considering a rehabilitation strategy, the engineering team determined that Strategy-1, parts replacement, could only have been considered for limited portions of the Presidio Viaduct. Even if such rehabilitation were done, the useful life of such a project could be as little as 25 years and another rehabilitation or replacement of the Presidio Viaduct would again be required.

The remaining structures that make up the bulk of Doyle Drive were built in a manner that prohibits the rehabilitation and preservation techniques of Strategy-1 and the structures would need to be replaced as addressed in Strategy-2.This is discussed in more detail below. [See Figure 2-1, for locations where strategies apply].

While these strategies have both been successfully applied to the Golden Gate Bridge rehabilitation program, implementing Strategy-1 at the Presidio Viaduct is difficult due to its poor condition. An *interim* rehabilitation is currently underway. This is a stop-gap measure to prevent near term vehicle weight restrictions on the structure. Long term improvements, such as the deck replacement have yet to be done. The task of determining the scope of long term rehabilitation was further complicated by the recent discovery of significant deterioration in the network of truss bracing. Compromised bracing downgrades seismic performance and increases the seismic risk exposure of the corridor. A detailed risk assessment is needed upon completion of the interim rehabilitation to determine the scope of interim corrective action.

Furthermore, the scope of rehabilitation cannot be limited to just structural considerations. A key goal of the project is to improve traffic safety. It was judged that some traffic safety improvements such as minimal widening with the deck replacement could be introduced in this strategy. This widening would add about 6 feet beyond the current edge of deck to provide 11-foot lanes and space to operate a moveable barrier. In order to keep the weight of a wider deck manageable, the deck replacement would have to use a lightweight deck system such as orthotropic steel plate, similar to what is used on the GGB. Moreover, to be able to reuse the substructure manageably, a seismic isolation system would have to be installed.

Reliable execution of this long term rehabilitation construction would require the use of temporary supports and construction of a detour structure. The rehabilitation concept for the truss spans, determined to be infeasible, is illustrated in Figure 2-1.

Figure 2-1. Doyle Drive Available Structural Improvement Strategies

Doyle Drive–Inventory of Structure Type

Structure Name	Structure Type	Strategy
Ruckman Under Crossing	Reinforced Concrete T-Beam	Replacement Required
Park Presidio Interchange	Reinforced Concrete T-Beam	Replacement Required
High (Presidio) Viaduct	Steel Deck Truss, Reinforced Concrete T-Beam, Steel Stringer	Full Rehabilitation to Extend Life < 30 years
Low (Marina) Viaduct	Reinforced Concrete T-Beam, Steel Stringer	Replacement Required

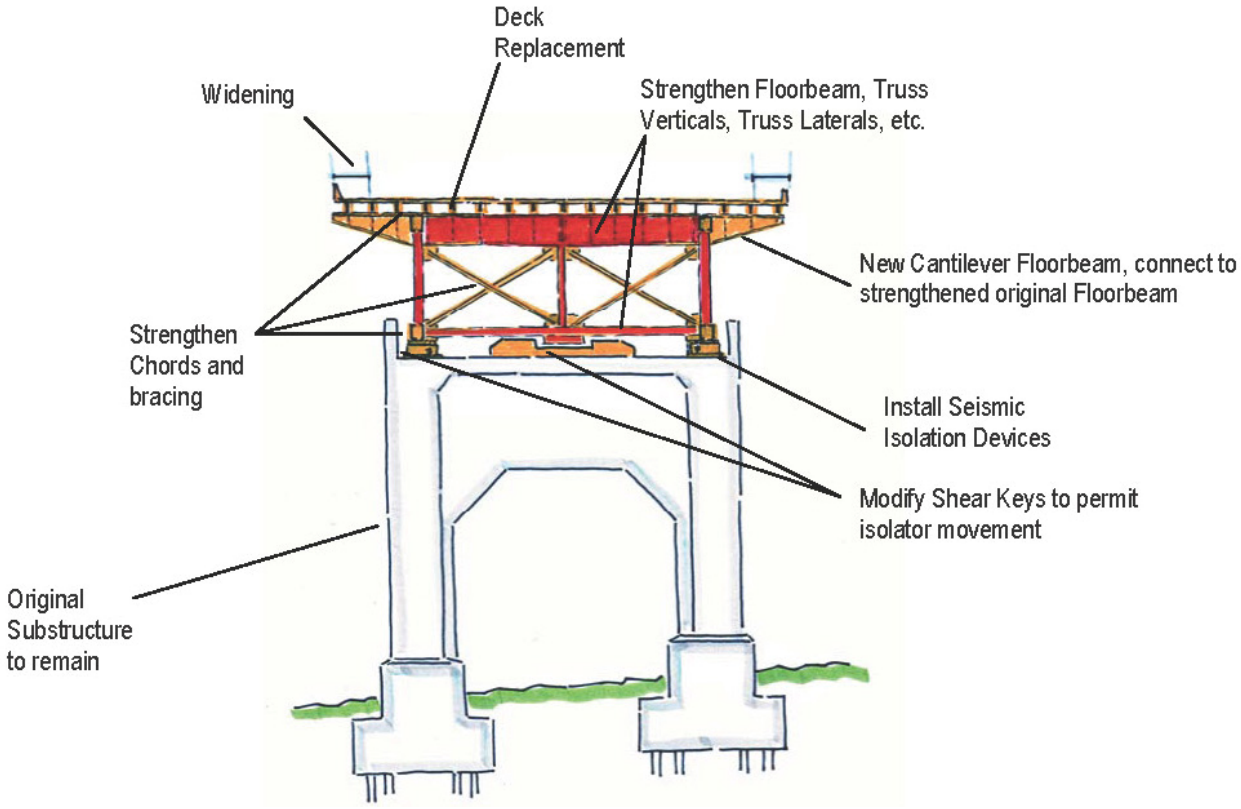


Figure 2-2. Rehabilitation of the Presidio Viaduct Determined to be Unfeasible

The steel stringer (a.k.a. steal beam) approaches of the Presidio Viaduct, which have no transverse floorbeam, would require widening of the substructure in order to support the additional deck width.

Conversely, rehabilitation is not a viable option for the historic Marina Viaduct or the Ruckman and Kobbe Under-crossings. This is also true for a portion of the historic Presidio Viaduct and its on-ramp and off-ramp. The reason behind this is that these structures are reinforced concrete (RC) T-beam bridges, a structure type that is not amenable to rehabilitation oriented improvements which retain original materials and functions.

The concrete pours creating these RC T-beam bridges had the deck, deck supporting stringers, beams and the substructure formed as one contiguous unit. As a result, removal is only possible with temporary supports since taking away any of these parts individually directly compromises overall structural integrity. Moreover, in the case of the Marina Viaduct, rehabilitation is precluded by the fact that it does not have the capacity to withstand the maximum credible earthquake.

As was true for Strategy-1, reliable execution of Strategy-2 would have required that temporary supports and detour structures be used.

Detours can be minimized by first installing temporary supports followed by substructure encapsulation that creates new load bearing cap-beams, columns and foundations. Installation of the temporary supports and the encapsulation would take place while the viaduct remains in service. Upon completion of this work the deck replacement operation would commence. Deck segments would be progressively replaced using a combination of regular night time as well as several extended weekend closures. This space saving and schedule trimming approach would require many temporary supports and lifting of large pieces. Alternately, a simplified approach using detour structures can be pursued. The detours would carry traffic and clear the space needed to conventionally construct an entirely new viaduct that resembled the above ground "look" of the original viaduct. Both concepts were found to have similar costs.

Marina Viaduct Rehabilitation Concepts Determined to have Unreasonable Cost and Limited Benefits are illustrated in Figures 2-3 & 2-4.

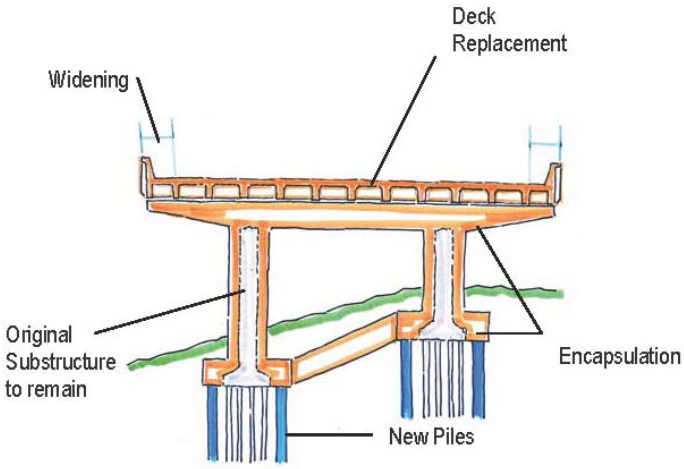


Figure 2-3. Deck Replacement & Substructure Encapsulation in Kind

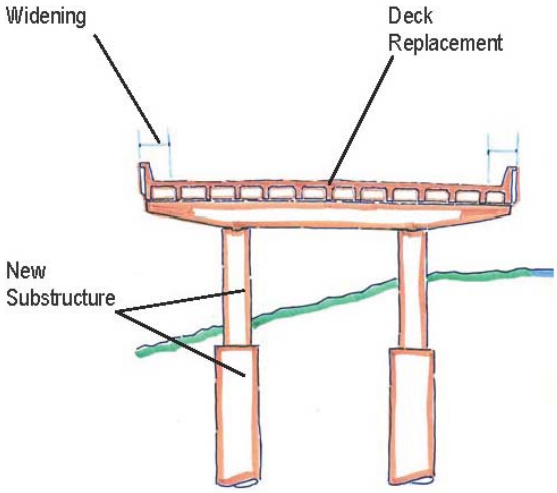


Figure 2-4. Complete Replacement

While preservation is a possible alternative, it is does not provide the same long-term reliable structural safety as the replacement alternatives. Furthermore, traffic safety improvements are limited by the geometric constraints imposed by preserving the Presidio Viaduct. Given the high cost and limited benefits of the rehabilitation Strategy, the Doyle Drive Project initiated studies into replacement alternatives.

2.3 Replacement Alternatives Evaluated Leading to the Consensus Decision that Presidio Parkway is the Preferred Alternative and Best Meets the Project Objectives

Given that rehabilitation would in fact replace 80% of Doyle Drive, complete replacement alternatives were considered. These Strategies are known as Replace and Widen and the Presidio Parkway.

The Replace and Widen alternative considered replacing the existing corridor with a similar set of viaducts designed to modern traffic and seismic safety standards. As with the rehabilitation alternative, maintenance of traffic during construction is a key consideration.

In contrast to this the Presidio Parkway was developed with a strategy known as Context Sensitive design, integrating the project into the contours of the surrounding area. The Presidio Parkway design realigns Doyle Drive closer to the ground by using a mix of viaducts, causeways, depressed roadways and tunnels. In general, this replacement alternative provides greater design flexibility; enabling the creation of the preferred alignment and profile that results in a project which enhances not only driver safety but also the national park experience.

Table 4 compares the improvement alternatives.

2.4 Summary and Conclusions

From the above discussion, several conclusions emerge:

- While it is possible to preserve portions of the Presidio Viaduct and extend its life for a few years, it is not possible to preserve the bulk of Doyle Drive, particularly the Marina Viaduct.

- An attempt to preserve a portion of Doyle Drive will also “preserve” the absence of shoulders along the roadway, narrow lanes, very tight curves and limited sight distances.

- Rehabilitation of Doyle Drive will cost, over time, the same or more than will the complete replacement and will result in a substandard structure which would require subsequent rehabilitation efforts and associated costs

It should be clear from the foregoing that complete replacement of Doyle Drive is necessary and more cost effective compared to a short-term yet expensive attempt to preserve the existing substandard facility. This document addressed only the structural imperatives that supported selection of the Presidio Parkway as the preferred alternative for a long-term solution to deal with the deterioration of Doyle Drive. When considering the full spectrum of environmental, aesthetic and operational issues, participating agencies and the Doyle Drive Citizens Advisory Subcommittee reached a similar conclusion and unanimously chose to replace Doyle Drive with the Presidio Parkway

Table 4. Comparison of Strategies for Improving Doyle Drive

Alternative Name	No Build	Rehabilitation Use Moveable Barrier, Preserve most of Presidio Viaduct, Replace Marina Viaduct in-kind	Replace & Widen New Wider Viaducts and Ramps	Replace with Presidio Parkway (Preferred Alternative) New Viaduct, Tunnel, Causeway & Depressed Roadway
Alternative ID	1	1a	2	5
Marina Viaduct	Not Sustainable	Replace	Replace	Replace
Presidio Viaduct	Not Sustainable	Preserve / Rehab	Replace	Replace
Park Presidio Interchange On-Ramp	Not Sustainable	Replace	Replace	Replace
Park Presidio Interchange Off-Ramp	Not Sustainable	Replace	Replace	Replace
Ruckman UC	Not Sustainable	Replace	Replace	Replace
Kobbe UC	Not Sustainable	Remain	Remain	Remain
Off Ramp Underpass	Not Sustainable	Remain / Widen	Remain / Widen	Replace
Paved Footprint Factor	1.0	1.15	1.85	1.15 with tunnels
Initial Cost[1] 2012 Mid Year Construction	N/A	At least $700,000,000	$813,000,000	$998,000,000
Additional Cost[2] + 10 years	Reactive Repairs until Replacement for all Structures is complete[3] $78,000,000	Presidio Viaduct Joint and Paint Upgrade $1,200,000		
Additional Cost[2] + 25 years < 75 years	Ultimately replace all Structures $800,000,000	Replace Presidio Viaduct $164,000,000	$0	$0

[1]Costs shown are nominal and are based on cost estimates (escalated to mid-year construction, 2012) from the Doyle Drive Draft Final Environmental Impact Statement and Report, February 2008.

[2]Costs shown are nominal and are shown as 2012 base year dollars.

[3]Cost of Reactive Repairs Ranges from Lane Closure to Bridge Closure & Detour Construction.

Table 4. Comparison of Strategies for Improving Doyle Drive (cont'd)

Alternative Name	No Build	Rehabilitation Use Moveable Barrier, Preserve most of Presidio Viaduct, Replace Marina Viaduct in-kind	Replace & Widen New Wider Viaducts and Ramps	Replace with Presidio Parkway (Preferred Alternative) New Viaduct, Tunnel, Causeway & Depressed Roadway
Operations[4]		Moveable Barrier $4,700,000		Tunnel Systems $10,400,000
Maintenance[4]	Routine Maintenance $1,500,000[5] Presidio Viaduct: Special Inspections[6] $8,900,000	Routine Maintenance $1,500,000[5] Presidio Viaduct: Special Inspections[7] $5,900,000	Routine Maintenance $1,500,000[5]	Routine Maintenance $1,900,000[5]
Total Cost	$888,400,000	$877,300,000	$814,500,000	$1,010,300,000

[4] Operations and maintenance costs shown are the estimated net present value of on-going operations and maintenance activities.

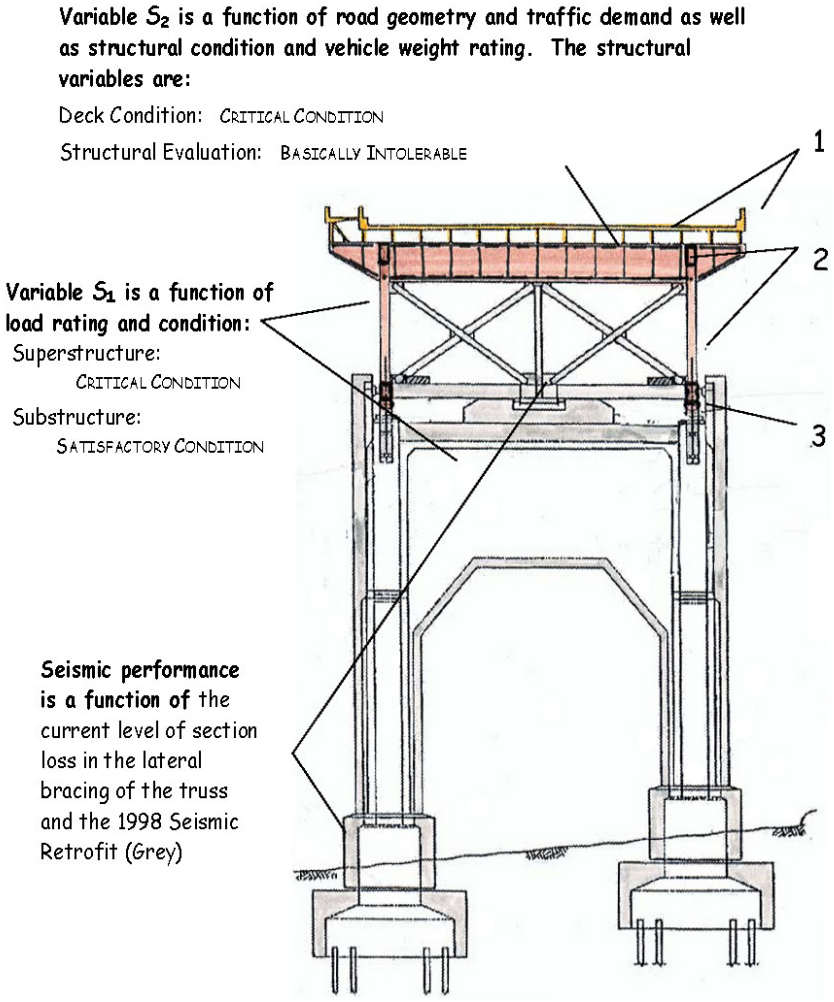
[5] Based on Statewide Bridge Management Plan Expenditures 2006/2007 (Periodic Routine Maintenance Inspections & Routine Repairs for Bridge Inventory dominated by Post Tensioned Concrete Bridges).

[6] Special Bridge Management Plan (Preventative Maintenance & Health Monitoring) to maximize life and current functions until structures are replaced. Presidio Viaduct – Annual Inspection Frequency as of 8/07.

[7] Special Bridge Management Plan (Preventative Maintenance & Health Monitoring) to maximize life and current functions until Presidio Viaduct is replaced.

3.0 STRUCTURE CONDITION FACT SHEETS

3.1 Presidio Viaduct



Presidio Viaduct-Typical Section

Notes on Condition

1. Reinforced concrete bridge deck is original and is delaminated from steel deck stringer at the expansion joints and is pounding. Barrier and light standards are in an advanced state of deterioration.

2. Truss is currently undergoing repainting and minor repairs, including many as-needed repairs to steel members. Thus far significant loss of section was observed in the lateral bracing system not previously upgraded, enough to raise concerns about seismic performance.

3. Bottom chord of truss is a fracture critical member requiring special inspection.

3.2 Marina Viaduct

Variable S_2 is a function of road geometry and traffic demand as well as structural condition and load rating. The structural variables are:

Deck Condition: POOR CONDITION

Structural Evaluation: MEETS MINIMUM TOLERABLE LIMITS TO BE LEFT IN PLACE AS IS

Load Rating: 24.5 T METRIC (VS. STD OF 32.4 T METRIC)

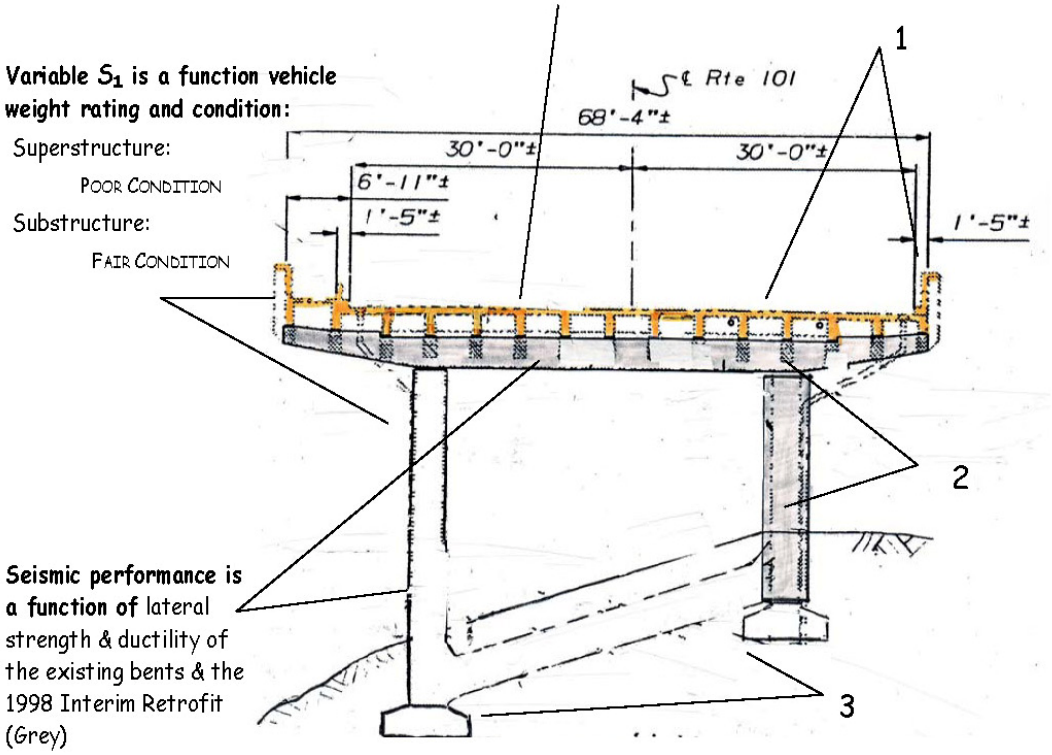
Variable S_1 is a function vehicle weight rating and condition:

Superstructure:

POOR CONDITION

Substructure:

FAIR CONDITION



Seismic performance is a function of lateral strength & ductility of the existing bents & the 1998 Interim Retrofit (Grey)

Marina Viaduct-Typical Section

Notes on Condition

1. Reinforced concrete bridge deck is original and is integral with the deck stringer forming a “T” beam. An overlay was placed in 1992 and is at the end of its useful life. Leaks in the expansion joints and salt air have deteriorated the concrete. Barrier and light standards are also in an advanced state of deterioration

2. The 1998 Interim Retrofit jacketed short columns vulnerable to shear failure and added seat extenders under the “drop-in” bridge deck spans. Retrofit increased strength of the bents to handle a 0.4 g seismic event that has 5% probability of occurrence in 10 years. Expected Seismic Performance is judged to be better than the un-reinforced masonry building stock in the City but less than the level for Ordinary Highway Bridges.

3. Original foundations, supported on lightly reinforced concrete piles and timber piles are located in a Liquefaction Hazard Area

3.3 Ruckman Under Crossing

Variable S_2 is a function of road geometry and traffic demand as well as structural condition and vehicle weight rating. The structural variables are:

Deck Condition: POOR CONDITION

Structural Evaluation: MEETS MINIMUM TOLERABLE LIMITS TO BE LEFT IN PLACE AS IS

Load Rating: 30.8 T METRIC (VS. STD OF 32.4 T METRIC)

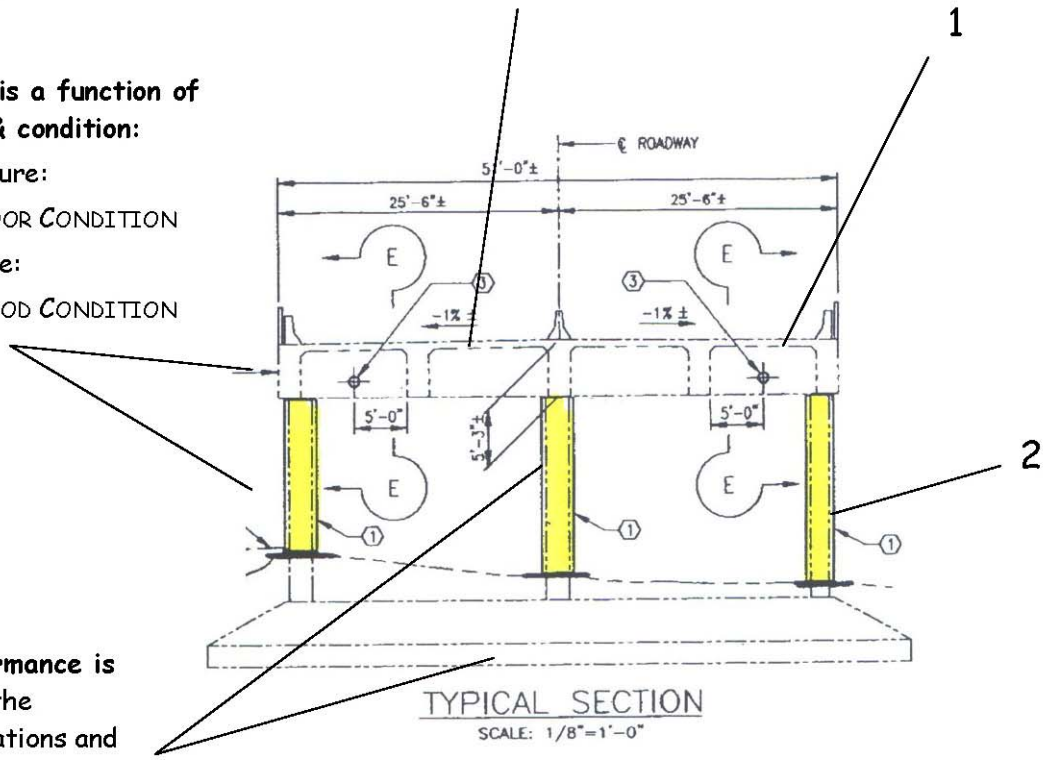
Variable S_1 is a function of load rating & condition:

Superstructure:

POOR CONDITION

Substructure:

GOOD CONDITION



Seismic performance is a function of the existing foundations and the 1995 Seismic Retrofit (Yellow)

Ruckman/Story UC-Typical Section

Notes on Condition

1. Reinforced concrete bridge deck is original and is integral with the deck stringer forming a “T” beam. The deck is bare and it is at the end of its useful life. Leaks in the expansion joints and salt air have deteriorated the concrete. Barrier and light standards are also in an advanced state of deterioration

2. The 1995 Seismic Retrofit jacketed columns and added seat extenders at the abutments. Expected Seismic Performance is judged to be that expected for Ordinary Highway Bridges.

3.4 Kobbe Under Crossing

Variable S_2 is a function of road geometry and traffic demand as well as structural condition and vehicle weight rating. The structural variables are:

Deck Condition: SERIOUS CONDITION

Structural Evaluation: SATISFACTORY CONDITION

Load Rating: 30.8 T METRIC (VS. STD OF 32.4 T METRIC)

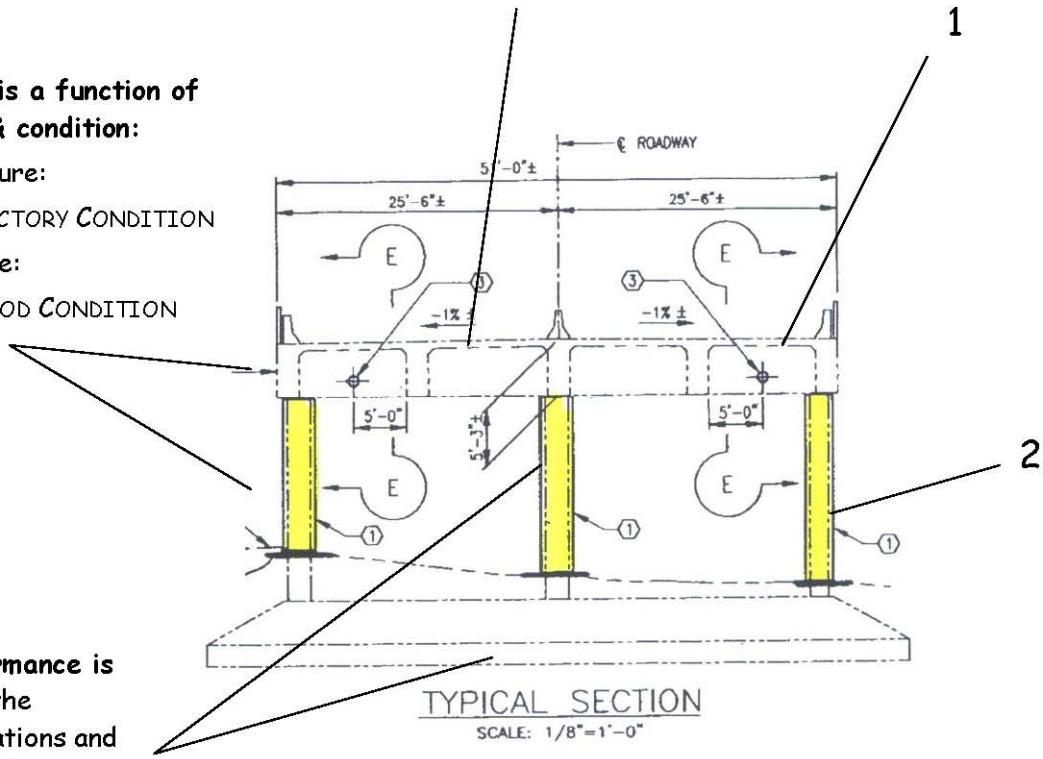
Variable S_1 is a function of load rating & condition:

Superstructure:

SATISFACTORY CONDITION

Substructure:

GOOD CONDITION



Seismic performance is a function of the existing foundations and the 1995 Seismic Retrofit (Yellow)

Kobbe UC-Typical Section

Notes on Condition

1. Reinforced concrete bridge deck is original and is integral with the deck stringer forming a “T” beam. The deck is bare and it is at the end of its useful life. Leaks in the expansion joints and salt air have deteriorated the concrete. Barrier and light standards are also in an advanced state of deterioration

2. The 1995 Seismic Retrofit jacketed columns and added seat extenders at the abutments. Expected Seismic Performance is judged to be that expected for Ordinary Highway Bridges.

APPENDIX A

Bridge Inspection Records Information System (BIRIS) Reports

98% of Deck area is classified as Structurally Deficient

88% of the deck area has an SR < 35.

Structure – ID number	Report Date	Deck Area (Square Meters)	SR	Owner
Marina Viaduct 34-0014	Feb. 2007	24,840	24.8	Caltrans
HWY 1 Bridges				
Kobbe Avenue UC 34-0017	Jan. 2006	3,360	58.3	Caltrans
Ruckman Avenue UC 34-0018	Jan. 2006	2,110	31.3	Caltrans
Presidio Viaduct 34-0019	Feb. 2007	8,680	2.0	Caltrans
Park Presidio Interchange Bridges				
N101-S1 Connector UC - 34-0020	Jan. 2006	220	65.7	Caltrans
N1-N101 Connector PUC - 34-0023G	Jan. 2006	30	71.5	Caltrans
N101-S1 Connector PUC - 34-0025G	Jan. 2006	20	68.5	Caltrans
N1-S101 Connector OC - 34-0040G	Jan. 2006	650	83.6	Caltrans
Lincoln Blvd UC - 34-0062	Jul 1999	510	69.1	Golden Gate Bridge
	Total Area	*40,420*		

APPENDIX B

Caltrans Seismic Safety Related Reports and Memoranda

Presidio Viaduct:

Reports and Memoranda 1993 - 2002

Marina Viaduct:

Reports and Memoranda 1993 - 2002

APPENDIX C

Sufficiency Rating Calculations

Illustrative Calculations include:

Presidio Viaduct

Marina Viaduct

Ruckman UC

Kobbe UC

NBIS Coding Terminology

APPENDIX D

Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, Report No. FHWA-PD-96-001)

Definition of Terms

Sufficiency Rating (SR):	Numerical Indicator of bridge's sufficiency to remain in service (not including seismic sufficiency). Range is from 0, insufficient, to 100, sufficient. Two thresholds are used to aid management decisions. An SR < 80 indicates eligibility for federal rehabilitation funds and an SR < 50 indicates eligibility for federal replacement funds.
Status:	Summary of the dominant deficiency of the bridge indicated as either *Structurally Deficient* or *Functionally Obsolete*
Structurally Deficient:	Indicates that a structural defect is present and that the *Structural Evaluation* should be referred for the severity and general location in the structural system
Functionally Obsolete:	Indicates that the design features, impacting usage not load carrying capacity, are no longer adequate for its current tasks.
Structural Evaluation:	Plain language description of the condition state of structural system (deck, superstructure, substructure and inventory load rating)