RIZZO Associates acquired International Civil Engineering Consultants, Inc. (ICEC) in March 2007, and became part of RIZZO a global engineering and consulting firm headquartered in Pittsburgh, Pennsylvania. This project was initially started under the name ICEC and is continuing through RIZZO.

In the preliminary seismic vulnerability study stage, RIZZO’s Dr. Joseph Penzien was contracted to serve as a member of the Design Review Board to evaluate the seismic performance of the main span and approach structures comprising the Golden Gate Bridge under the maximum credible earthquake condition and identify the seismically vulnerable details, substandard members and joints, and foundation deficiencies. In the detailed design of seismic retrofit measures stage, under subcontract to T. Y. Lin International, we provided consulting services in seismic ground motion study for the bridge and was a member of the Peer Review Panel to review the detailed design of seismic retrofit features generated by consultants to the Golden Gate Bridge.

The ABAQUS and KARMA finite-element models for the Main Span, South Viaduct, North Approach Viaduct, Pylon S1, Pylon S2, and Fort Point Arch were converted to ADINA Models taking into account geometric and material non-linearity, for use in seismic retrofit design for the Golden Gate Bridge. The seismic response analyses of converted ADINA models were performed and the results were correlated with the corresponding results obtained from ABAQUS.

A seismic evaluation and simulation of a hypothetical unzipping of suspenders of Golden Gate Bridge was conducted for security measures. RIZZO was retained by Golden Gate Bridge District to convert nonlinear models of the Golden Gate Bridge used by seismic retrofit design contractors to develop nonlinear seismic models of the retrofitted Main-Span (Suspended Structure), South-Viaduct, and North Approach Viaduct structures using finite-element program ADINA in order to verify safety retrofit features and seismic performance of the bridge. The detailed nonlinear models were developed for the suspended Main-Span, South Viaduct, South Anchorage Housing, Pylon S2, Fort Point Arch, Pylon S1, and North Approach Viaduct Structures. In addition, the nonlinear models developed are to be used by the District for correlating instrument-recorded bridge response in future earthquakes occurring in the region.

Special Studies were performed to evaluate effects on seismic response of the bridge due to proposed hardening retrofit of the north and south tower legs. The evaluation was carried out by first modifying the converted nonlinear ADINA model of the suspended bridge to reflect the hardening-retrofitted condition of the tower legs and then performing a nonlinear seismic response analysis using the modified model to determine the seismic response of the retrofitted bridge.

In addition, NEABS nonlinear computer model was converted to corresponding ADINA model for the North Approach Viaduct. The converted model was validated and modified to reflect as-built retrofitted configurations including the end stringers span adjacent to the North (Marin) Abutment.

Currently, RIZZO is sub-consultant to HDR, Walnut Creek, CA for the Phase IIIB for seismic retrofit of Main Span (Suspended Structure) of the Golden Gate Bridge.
GOLDEN GATE BRIDGE SEISMIC RETROFIT PROJECT

Types of Services provided:
- Peer Review of Seismic Ground Motions.
- Evaluation of Seismic Performance of Retrofitted Bridge Structure.
- Development of Non-linear ADINA model for Main Span, Pylon S1, Pylon S2, Fort Point Arch, South Viaduct, and North Approach Viaduct. Correlation of Instrument-Recorded responses for Future Earthquakes with the ADINA Models.
- Conversion of ABAQUS and KARMA finite-element models to corresponding ADINA Models for Seismic Retrofit Design Use.