Gianella Bridge (Gianelli Bridge)
California State Highway 32
spanning Sacramento River
Hamilton City vicinity
Glenn (and Butte Counties)
California

HAER No. CA-44

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Western Regional Office
National Park Service
Department of the Interior
San Francisco, California 94102

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HISTORIC AMERICAN ENGINEERING RECORD

Gianella Bridge (Gianelli Bridge)

HAER No. CA-44

Location: Spanning the Sacramento River on State Highway 32 in Glenn and Butte Counties; located just east of Hamilton City, Glenn County, California

UTM: 10.586000.44000410
Quad: Nord

Dates of Construction: 1908-1911. Altered 1937, 1954

Present Owner: California Department of Transportation
1120 N Street
Sacramento, California 95814

Present Use: Vehicular bridge

Significance: The Gianella Bridge is the oldest remaining highway swing bridge in California. It is important in local history for its relation to events in local economic and agricultural development. It is the work of John B. Leonard, one of the most important early 20th century bridge engineers. It was listed on the National Register of Historic Places in 1982.

Historian: John W. Snyder
Chief Architectural Historian
Office of Environmental Analysis
California Department of Transportation

Transmitted by: Jean P. Yearby, HAER, 1985

DESCRIPTION

The Gianella Bridge (also known as the Gianelli Bridge) is composed of two steel through Pratt truss approach spans, each 133 feet in length, and one steel through Pratt truss swing span, 311 feet long. The bridge rests on mass concrete piers and wing abutments. The structure carries two traffic lanes between metal beam guardrails, crossing the Sacramento River with no skew.

As built, the bridge was timber-decked. The original deck was removed in 1937 and was replaced by laminated decking with an asphalt wearing surface. In 1954 the timber stringers and laminated deck were replaced by steel stringers and an open steel grate-type deck. At that time the original lattice steel railings were replaced by the present guardrails to provide increased protection for the truss members. By 1938 the small number of required openings of the bridge led to disconnection of the electrical machinery and provision for manual operation of the swing span, an operation which required eight men to open and close the bridge. In 1972 an agreement was reached with the Coast Guard that the bridge need not be maintained for opening, but that it would have to be restorable to that condition within six months of written notification by the Coast Guard. Accordingly, the bridge has not been opened since that time.

HISTORY: THE BRIDGE

In early 1907 (and for some time prior) both Glenn and Butte Counties in Northern California had desired to bridge the Sacramento River but could not reach an agreement on funding or site. (The center of the river marks the boundary between the two counties.) Spurring the desire for a link between the two counties was a current boom in sugar beet farming. Alta California Sugar Beet Company had sited their refinery in Hamilton City, on the Glenn County side of the river, and direct access to this facility was needed by Butte County beet farmers. However, political and business leaders in Chico (Butte County) were pressuring county officials to locate the new bridge near the site of an earlier bridge a few miles downstream from Hamilton City, feeling that this would provide the shortest route from Glenn County to Chico and thus provide business from that source. Glenn County, on the other hand, sought Hamilton City as the bridge site in order to more directly serve the sugar beet refinery and their own business interests. The impasse might have proven insurmountable, but for support given to the Glenn County position by Vincenzo Gianella, a prominent Butte County land owner and businessman.

Vincenzo Gianella was born in Switzerland and came to California as a small child with his parents. He attended public schools and was graduated from St. Mary's College. After graduation, he bought a ranch on the Butte/Yuba County line near Honcut and raised stock and grain (probably barley). He gradually increased this holding to some 3,000 acres. In

1903 he bought the old Colby Ranch, located ten miles from Chico and three miles east of Nord; this property provided four miles of frontage on the Sacramento River across from Hamilton City. This 3,500 acre purchase gave Gianella a total of 6,500 acres of Butte County. Gianella was a prominent member of the Chico Lodge of the B.P.O.E. (Elks) and was a director of the Butte County National Bank of Chico. His plan was to devote extensive amounts of the former Colby Ranch to the cultivation of sugar beets. With the refinery located directly across the river from his property, Gianella naturally favored the siting of the new bridge at that location and put considerable pressure on the Butte County Board of Supervisors to reach that goal.

There were other bridge proposals and economic stimuli affecting the area at that time. The Western Pacific Railroad, last of the transcontinental lines, was nearing completion and rumors of a branch line from Oroville to Chico abounded. The Northern Electric Railway, headquartered in Chico, was building to Sacramento (and an eventual link there with the Oakland, Antioch and Eastern which would spawn the Sacramento Northern Railway and provide a direct link to San Francisco).

In order to serve the sugar refinery, the Northern Electric began construction of a branch line to Hamilton City, proposing to bridge the Sacramento River near the old bridge site, almost precisely where the Chico citizenry desired their bridge.

This latter event brought the War Department into the picture. This agency disapproved of two parallel bridges and applied pressure for the adoption of a combination railroad and vehicular bridge. Unfortunately the counties, who could not even reach a funding agreement between themselves, found that the prospect of a third party thoroughly confused the situation. The railroad, for their part, could not find an agreeable funding solution either and so forged ahead independently.

By May 1907 the Butte County Board of Supervisors had formed a Bridge Committee to study the problem and make recommendations. In that month the Committee reviewed seven proposals. These included one proposal for a stone masonry arch bridge, two proposals for reinforced concrete bridges and four proposals for steel bridges. They recommended adoption of plans by John B. Leonard of San Francisco for a reinforced concrete bridge. The Supervisors accepted the recommendation, with the optimistic provision that falsework be across the river within two months.

Two months later the two counties still had not been able to agree on a location, much less begin the erection of falsework. Gianella was applying pressure for siting the bridge at the location of his property. And the Northern Electric, in order to serve Hamilton City in time for the 1907 beet rush, had built toward the river from both ends of the branch line and erected a "temporary" pontoon drawbridge to serve until their proposed all-steel, two span drawbridge could be built. (As it turned out, the railroad was to use this "temporary" bridge for at least three years, mooring the pontoons to the river bank during winter floods; the experience of electric-powered freight trains crossing such a structure must have been impressive indeed.)

In August 1907, perhaps as a result of the railroad's activity, the Butte County Board of Supervisors voted unanimously to approve the Gianella site (it is worth noting that the bridge was never formally named for Gianella; contemporary reports referred to the "Gianella site"). Later that month, Butte County voters approved the bridge bonds. It then took until October for the two counties to enter into an agreement to employ Leonard to fix the exact site and take soundings, which he commenced immediately.

By the following March, the Board of Supervisors had decided against the reinforced concrete proposal. On March 11, 1908 the Boards decided to erect a steel swing span bridge with concrete piers and abutments, and utilizing electricity to power the swing span. Leonard, more visionary than the Supervisors, urged that a concrete floor be used in order to support heavier loads which he felt later years were sure to bring. But the Supervisors, for reasons of cost, voted for the less expensive timber floor system. The bridge was to cost $150,000.

In April the Northern Electric, tiring of waiting for proposals of a joint venture from the counties and seeing a good prospect, was awarded a franchise to construct a toll vehicular bridge in connection with their railroad bridge at the downstream site. The plans and specifications for the Gianella Bridge were adopted on April 16 and the Notice to Contractors published in the Chico Record on April 19, 1908. On May 5, the Supervisors opened bids and found that of Cotton Brothers of Oakland at about $149,000. The Butte Supervisors accepted this bid, but the Glenn Supervisors rejected all bids which necessitated calling for new bids. On May 19, 1908, with new bids in, the contract was awarded to Cotton Brothers for $149,780. Work was to commence within one week and was to be completed by January 1, 1909. No one realized how optimistic this latter provision was to prove.

June 1908 saw construction underway in earnest, with Cotton Brothers driving piles by June 6. On June 25 the first major shipment of materials arrived on the river steamer DOVER: 2,000 bags of cement and 200,000 board feet of lumber and timbers. By December, one month from the specified completion date, construction had slowed as the contractors awaited delivery of steel for the draw span. And then nature struck.

The winter of 1908-09 was, by contemporary records, extremely wet and many Northern California rivers ran at record levels. Many towns were inundated and many bridges washed out. In January 1909 floodwaters damaged the newly-completed dolphin and center pier; bottom scour caused the latter to lose its footing and tilt out of plumb. By March, squabbling had begun anew. Cotton

Brothers refused to accept liability to replace the pier, though their contract clearly stated that any damage prior to acceptance of the bridge was the responsibility of the contractor, a point which the joint Boards of Supervisors repeatedly cited. Leonard, for his part, claimed that the mistake was due to conditions never before encountered on the Sacramento River. He had discovered a rock-like stratum beneath the river mud, and his plans called for pier footings to be driven into this stratum. However, Leonard claimed, this stratum, when disturbed, proved to have the quality of dissolving "like sugar," as it in fact did when exposed by the bottom scour of the floodwaters. The disagreements and threats of litigation dragged on until July 1909 when Cotton Brothers agreed to bear the expenses of pier removal and replacement and to finish the bridge. They proposed to use a larger center pier on deeper piling, protected by rock and sheet steel, and an upstream dolphin of concrete rather than of wood. The completion date was changed to January 1910.

Construction progressed slowly when Cotton Brothers ran into difficulty in removing the damaged center pier, it being necessary to blast it out with small charges. In December 1909 they asked for and received an extension until August 1, 1910. On April 2, 1910 their pile driver struck a 60,000 volt line of the Northern California Power Company and five workers were thrown into the river by the jolt and injured. In early August they asked for a further extension until August 15. But this time the Supervisors refused, invoking a daily penalty for each day after August 1. What the cost was to Cotton Brothers in terms of penalty is not recorded; however, the bridge was finally informally accepted by the joint Boards following their inspection on December 8, 1910, four months after the extended completion date and almost two years after the original projected date of completion. The final cost of the bridge was estimated at $260,000 to $270,000. Even with the cost overrun, it was hailed as a bargain sure to well serve the two counties to their best advantage.

HISTORY: THE DESIGNER

John Buck Leonard was the youngest of three children, born to Joseph C. and Martha (Haynes) Leonard in Union City, Michigan in 1864. The elder Leonard, a native of Smyrna, New York and a cobbler by trade, had made what was intended as a brief stop in Union City on his way to California in 1842. The visit soon lengthened beyond his original intentions. Upon meeting and marrying Martha Haynes, also a native of New York, in 1845, all thoughts of the journey to California ended as the Leonards settled permanently in Union City. During the ensuing years Joseph plied his trade as a cobbler, was elected to the State Senate in 1853, engaged in farming, surveying, the land agent business and was active in Union City politics.

After an education in Union City schools, John studies engineering at Michigan State, Illinois University and the

University of Michigan. In 1888 he completed the journey begun years earlier by his father. Joining others lured by Southern California's real estate boom, he arrived that year in San Diego. From there he travelled immediately to Los Angeles where he gained a position in that city's Engineering Department. In 1889 he moved north to San Francisco, the city which was to be his home for the rest of his life.

During the early 1890s Leonard worked for several engineering firms as a draughtsman and civil engineer. His first six years in San Francisco included employment by American Bridge and Building Company and by Bay City Iron Works. Involved in iron and steel design and in bridge building, these firms offer clues as to the focus of Leonard's education. In 1895 the Southern Pacific Railroad employed him as a draughtsman in their Maintenance of Way Department, and in that same year he presented a paper before the Technical Society of the Pacific Coast on the rebuilding of the railroad's train ferry slips at Benicia and Port Costa. Leonard's role in the project had been in the design of the iron elements of the slips. The publication of his paper, however, provides another vital clue: listed in the Society's Transactions as a member, the young Leonard likely knew and associated with fellow members engineer Ernest Ransome and architect George Percy, pioneers in early reinforced concrete development and use. Leonard's interest in the potential of reinforced concrete may well have been fostered at this time. Supporting this hypothesis is the fact that from 1897 to 1899 Leonard opened his own business in concrete and artificial stone contracting. But while he achieved some measure of success in this century, the time was not yet right for widespread acceptance of reinforced concrete. Thus the years 1900 to 1903 found Leonard in the employ of Healy, Tibbetts and Company, a San Francisco engineering firm specializing in wharf, bridge and railroad building. As Chief Engineer for the company, Leonard travelled to Samoa to oversee a Navy dock-building and port installation contract. But all these activities were merely preliminaries, for in 1904 he opened his own office in the Crossley Building as a consulting civil engineer.

One of Leonard's first independent contracts involved him with the Truckee-Carson Irrigation Project at Hazen, Nevada as consulting engineer for the San Francisco Construction Company. By March 1905 Leonard was, in that capacity, corresponding on letterhead which listed his skills as "steel buildings, roof trusses, bridges, viaducts, masonry structures, foundations, water power plants." Concrete is conspicuous in its absence. Yet Leonard must have been working diligently behind the scenes, for little more than two months later events had occurred which were to place him in the forefront of the field of reinforced concrete on the West Coast. May 1905 found Leonard's letterhead now proclaiming his work to be in "Reinforced Concrete" and "Structural Steel." It also listed him as "Agent for Corrugated Bars," this being a patent reinforcing steel manufactured by the Expanded Metal and Corrugated Bar Company of St. Louis.

Simultaneously Leonard won a competition for his first reinforced concrete bridge, and was retained to execute the engineering design for what was billed as the largest reinforced concrete building in the world. Perhaps most important was the beginning of publication in May 1905 of Architect and Engineer of California. From 1905 to 1912, Leonard was the magazine's Associate Editor for Reinforced Concrete. Thus, simultaneous events found Leonard achieving recognition of his design skills as evidenced by his commissions, acquiring a lucrative marketing agency, and gaining a vehicle in which to expound his views as a proponent of reinforced concrete, on building code revision, on building inspection and in which to illustrate his own designs.

The 1905-1906 period was a critical one in Leonard's career. While he had achieved his first major commissions, he had still to overcome traditional opposition and restrictive building laws to see widespread acceptance of reinforced concrete. San Francisco building officials became a prime target for, still influenced by a powerful brick lobby, they refused to amend the city's building laws to allow the construction of reinforced concrete buildings. In his position with Architect and Engineer of California Leonard fielded editorials and articles which best supported his proponency of reinforced concrete. Thus his own writings and articles by other prominent engineers and architects appeared, chiding officials and supporting use of the new material. In September 1905 engineer Lewis A. Hicks noted the West had been slow to recognize the merits of reinforced concrete. In August Leonard wrote both an article and an editorial reproaching city officials. The article, which presented the specifications for reinforced concrete of the new Chicago building ordinance, concluded: "The San Francisco authorities have made no move in this direction as yet. When will they? is the question asked by those most interested." The editorial attacked the San Francisco ordinance as "...too antiquated for these days of progression..." and called for the authorities to amend it to allow for reinforced concrete buildings. In October, architect Ralph Warner Hart wrote of his design for the Bekins warehouse, San Francisco's first reinforced concrete building, then under construction. Hart was forced to admit the structure was being erected in violation of city codes, and found it ironic that the city was among the last to recognize a type of construction which had been pioneered there in the 1870s. In December 1905 there appeared articles by three of California's more prominent architects which favored the use of reinforced concrete. Charles Whittlesey wrote that "...the future will show that reinforced concrete will be the universal building material..." Harrison Albright stated that the importance of reinforced concrete was such that "...no architect or civil engineer can afford to be without a thorough knowledge of its properties and applications..." Albright noted the applicability of reinforced concrete to almost any form of construction, but cautioned against the need for proper reinforcement. He therefore recommended careful review of all drawings by an experienced engineer and rigid inspection during construction. Even conservative Octavius Morgan, who admitted he was prejudiced in favor of brick, found reinforced concrete best suited for beams and girders and for heavy structures such as warehouses, bridges and loft buildings. This increase in activity in the field of reinforced concrete led the University of California engineering department to undertake structural tests of the material, perhaps with an eye toward the San Francisco building laws. In reporting the results of the tests, Professor Charles Derleth, Jr. noted "...at the present time, the use of reinforced concrete is becoming so general that it may be considered almost a fad..." Finally, an editorial penned by Leonard appeared in February 1906. It noted the recent construction on the Pacific Coast of some of the largest reinforced concrete structures in the United States. It also called attention to the ready availability of concrete on the local construction market, which shortened construction time and gave the investor a completed structure in less time than any other material. Last, it stated the ability of reinforced concrete, through greater durability and reduced maintenance requirements, to demonstrate greater economy in compared costs. These themes were to appear again and again in Leonard's writings.

During this period Leonard had gained his first reinforced concrete bridge commissions. With the completion of his Truckee-Carson Irrigation Project involvement, he successfully competed to design a new bridge across the Truckee River in Reno. The bridge, virtually unmodified today, was erected in 1905 as a two-span, filled-spandrel arch, originally carrying two traffic lanes, two sidewalks, and a center streetcar track. Illustrative of Leonard's subsequent bridges, even in this first example the gracefully proportioned arch rings spring to a remarkably thin section at the crown. And in keeping with the bridge's urban setting, Leonard chose Beaux-Arts detailing in the form of decorative railing and lighting elements.

With the Truckee River commission behind him, Leonard set out to sell county officials in California on reinforced concrete bridges. His arguments, foreshadowing the February 1906 editorial, balanced higher initial cost against reduced maintenance and increased useful life when comparing concrete bridges with steel bridges. The engineer's persuasive arguments and cost figures brought him three immediate commissions: the San Joaquin River Bridge at Pollasky, near Fresno; the Dry Creek Bridge at Modesto; and the Stanislaus River Bridge at Ripon. These San Joaquin Valley bridges demonstrated well Leonard's competence of design and his daring use of a technology and material in which he so strongly believed. The Pollasky Bridge incorporated ten 75-foot spans in a stately march across the bed of the San Joaquin River; and while individual span length was less than at Reno, its composite length made Pollasky the longest reinforced concrete bridge in the United States at that time. At Dry Creek and Ripon, Leonard's designs were noteworthy for their individual span lengths, 112 and 110 feet respectively, with the Ripon Bridge employing two spans.

At this same time, Los Angeles architect Charles Whittlesey engaged Leonard to prepare the engineering design for his Temple Auditorium in Los Angeles. Whittlesey, never overly modest with regard to his own work, termed the structure "...in some respects, the most remarkable building ever erected of this material." Of reinforced concrete throughout, the center section of the building rises nine stories, while overall the structure covers an area 165 by 175 feet. Leonard's engineering provided reinforced concrete girders up to 42 feet in length, carrying a concentrated center load of 100 tons each. But it was in the design of the auditorium itself that Leonard excelled. This space, then the largest theater west of Chicago, measured 165 by 110 feet and seated 3,500 with provision for seating an additional 1,500 for special events. In order to provide the best possible sight lines, Leonard carried the auditorium's enormous balcony on huge reinforced concrete cantilevers, so that there were no supporting columns to obstruct from seats on the main floor below. And to cover the auditorium Leonard designed a reinforced concrete roof carried on reinforced concrete trusses having a clear span of 110 feet.

Leonard's engineering expertise is reflected in these earliest ventures. In an era marked by the failure of reinforced concrete bridges and buildings during construction due to improper design, Leonard's structures utilized carefully calculated placement of reinforcement. Competence of design became Leonard's hallmark. Reno, Dry Creek, Ripon--all remain in service carrying traffic far in excess of that for which they were designed. And the Temple (now Philharmonic) Auditorium remains one of the finest theater spaces in Los Angeles.

1906 brought the watershed event in Leonard's career. When the great San Francisco earthquake rumbled ashore and down the San Andreas Fault in the predawn hours of April 18, reinforced concrete was still a controversial material in the minds of many engineers, architects and building officials. By the time the fires were out and the evaluation of damage begun, it was apparent that a reassessment of reinforced concrete was due, and that proponents' claims for the material bore further consideration. The disaster touched Leonard directly as well, as he lost both house and office to the great fire. Yet in the midst of the loss and while living in a tent in a park near Fort Mason, Leonard found the ability to look to the future. In a letter to his sister in Los Angeles Leonard indicated a determination to stay in San Francisco despite the awful conditions, writing: "I am loth \sic} to leave for there is going to be plenty for me to do I think."

The brickmakers' claims of permanent construction and their cries against reinforced concrete were belied by the mountains of brick rubble that had been San Francisco, Santa Rosa, San Jose and Stanford. In the midst of the shattered brick buildings, the early Ransome/Percy reinforced concrete buildings and bridges stood firm, as did Hart's Bekins Warehouse. Even Octavius

Morgan, inspecting the ruins even as the fires still burned, was forced to conclude the monolithic qualities of reinforced concrete made it the most earthquake and fire proof construction. It was obvious to those connected with the building profession that the disaster provided a unique opportunity to study design and construction techniques. Thus it was that Professor Charles Derleth, Jr. of the University of California contacted Leonard and other leading engineers to begin discussions. Leonard's reply: "Though the Crossley Building has shrunk from sight, Jno. B. Leonard and Reinforced Concrete will be more in evidence than ever."

On May 11, 1906 they published a notice in Bay Area newspapers calling a meeting of engineers to "...intelligently observe and analyze the structural effects...(of) the recent earthquake and fire...for exchange of data...to lead to...a concert of opinion as to future practice." The group, 100 strong, met on May 17, 1906 to form the influential Structural Association of San Francisco. This organization eventually included most engineers, architects, builders and contractors in the Bay Area. The stated purpose of the Association was "...investigation and discussion of earthquake and fire phenomena in San Francisco, and the formulation of conclusions as to the manner in which the best types of building construction should be modified to conform to these observations." The membership was expanded beyond engineers to include "(A)ll persons directly concerned in the design, manufacture and use of structural and fire-resisting materials..." A nominating committee was appointed consisting of Leonard and fellow engineers C.H. Snyder, Robert Oliphant and F.A. Koetitz. Subsequently, Leonard was appointed to head the Subcommittee on Reinforced Concrete, and to membership on the Executive Committee. The Association reported that those serving on the various committees were "...experts in their respective lines of work..." These appointments were tacit proof of Leonard's personal and professional standing with his peers.

Almost immediately, Leonard set forth his goals for the subcommittee. Chief among these was a thorough examination of the Bekins Warehouse to gain data pertaining to its performance in earthquake and fire. Not surprisingly, <u>Architect and Engineer of California</u> noted the existence of the new organization and commented on its "...especial agility in promoting and encouraging the use of reinforced concrete." The Association, meeting weekly, remained in existence for a little more than six months. Some members, sensing time as a factor, urged the Association to adopt revisions to the San Francisco Building Ordinance solely to indicate progress was being made. Characteristically, Leonard, in the course of discussion of the new Ordinance, cautioned against hasty revisions, calling instead for the group to take the time to understand all that had been studied. By the time the Association disbanded in early 1907, several of Leonard's goals had been realized: the new San Francisco Building Ordinance, drawing upon the reports and work of Leonard's subcommittee, allowed for reinforced concrete buildings; both the public and the building profession had been made more fully aware of the potential of reinforced concrete; and Leonard's continuing call for better building inspection influenced the San Francisco Grand Jury to request the appointment of nine more municipal inspectors.

In addition to his role with the Structural Association, the Board of Trustees of Stanford University retained Leonard, along with engineer John D. Galloway and architect Henry A. Schulze to inspect earthquake damage to the University and to recommend the best means of reconstruction to provide an earthquake and fire proof campus. This was yet another tribute to Leonard's professional status, as Stanford's engineering faculty and school were second only to the University of California within the state. As in San Francisco, the committee found that reinforced concrete had withstood the temblor almost unscathed, while campus brick and stone masonry--notably the Memorial Arch and Chapel--had suffered greatly.

During his tenure with the Structural Association, Leonard did not rely solely on that role to effect changes and to increase use of reinforced concrete. He also continued to field articles and editorials in Architect and Engineer of California. Continued opposition to reinforced concrete necessitated this activity. Even amid the aftermath of the earthquake, resistance of the brick industry to reinforced concrete remained vehement. Virtually ignoring the destruction around them, the brick men claimed that brick buildings had proved the salvation of San Francisco. Likewise, knowing full well that their own influence had effectively precluded any pre-earthquake reinforced concrete buildings, they challenged reinforced concrete proponents to name reinforced concrete buildings which had withstood earthquake and fire, claiming instead they had proof of the failure of the new material. In reply, Leonard leveled a withering barrage of facts and figures from himself and others.

In May 1906 he rightly pointed out that the lack of all-reinforced concrete construction in San Francisco prior to the earthquake was due to an "...antagonistic building ordinance..." Citing his own inspections and those of other engineers and architects,m he revealed that reinforced concrete floors and fireproofing had come through the disaster without instance of failure, concluding that reinforced concrete was to be the "...most favorably considered material for the rebuilding of San Francisco..." Taking opportunity to call attention to his own work, Leonard pointed out that his bridges at Pollasky, Modesto and Ripon had withstood the shock without the slightest sign of damage, in spite of the fact that they were still under construction and thus at less than full strength.

Editorials attributed to the pen of Leonard noted the responsibility for the past failure of city authorities to permit reinforced concrete construction lay with the brick industry and labor, and warned that failure to rectify this situation would surely pave the way for a repetition of the disaster. These editorials accurately pointed out that investors would be quick to learn from the past event and would desire to rebuild in reinforced concrete. Under Leonard's editorial direction, Architect and Engineer of California reprinted an article from the San Francisco Bulletin which termed the brickmakers' objection to reinforced concrete "...preposterous, insincere and selfish..." and pointed out that architects, engineers and building contractors now recognized reinforced concrete as superior to brick. Looking accusingly again to the brick lobby, the Bulletin wrote: "The time has come, however, when the city's need is stronger than the political influence of any special interest."

Other articles supporting Leonard's position appeared in the magazine; their editorial selection must again be attributed to Leonard. Engineer Maurice Couchot was openly amazed at the extent of failure of brick masonry, and wrote of the success of reinforced concrete construction and fireproofing, citing as examples Ransome's Academy of Sciences flooring in San Francisco and his borax factory in Alameda, and Hart's Bekins Warehouse. Hart himself wrote of the splendid showing his building had made, with articles appearing in Architect and Engineer of California and in nationally-circulating Engineering Record. Architect Charles W. Dickey gave examples of the failure of brick construction, citing buildings in Alameda. Turning to the successful showing made by the Bekins Warehouse, Dickey theorized that buildings up to six stories might be built entirely of reinforced concrete, and that lessons of the earthquake might prove of value in changing San Francisco building laws. And a young graduate of engineering from the University of California, William P. Day, noted that the adherents of reinforced concrete could hardly have hoped for a better showing to strengthen their position.

Leonard's stance was also supported in other published sources, both locally and nationally. American Builders Review, B.J.S. Cahill's San Francisco-based competitor to Architect and Engineer of California, carried a number of articles dealing with the effects of the earthquake and fire and touting the qualities of reinforced concrete. These were authored by Professor Charles Derleth, Jr., Leonard's cohort in the Structural Association, whose writings also appeared in Architect and Engineer of California and other sources at about the same time. Like Leonard, Derleth pointed to the brick industry for the lack of reinforced concrete construction prior to the earthquake, and also called for competent design to avoid the possibility of building failures.

National engineering periodicals also carried news of the disaster and these echoed the findings of the local publications. Indeed, Leonard authored articles for Engineering Record in which his strong advocacy of reinforced concrete again stood forth. Writing for the national scene, Leonard stated the success of reinforced concrete in withstanding earthquake and fire. He was also quick to point to the building of public confidence in reinforced concrete "...because of their expressed convictions of the insecurity and danger of brick structures based upon their observation during the destruction of a city." Even Corrugated Bar Company cited their San Francisco agent's (Leonard's) positive reports of the performance of reinforced concrete in letters to Engineering News and Engineering Record. The brick industry could not have chosen a more dedicated, forceful opponent.

The post-earthquake period produced a hiatus in Leonard's bridge work as the engineer found his services in great demand for building design. Indeed, by September 1907 Leonard had undertaken the reinforced concrete design for more than a score of San Francisco buildings. In the design of at least two of these buildings, Leonard found himself in association with leading architects. In 1906 he executed the design of the Sheldon Building (recently demolished), one of San Francisco's first large reinforced concrete buildings. The structure, with a terra cotta exterior, was built in 1907 and was the produce of architect Benjamin G. McDougall, himself an important early user of reinforced concrete. Also in 1906 Leonard handled the engineering of the MacDonough Estate Building for architect William Curlett. This seven story structure, whose facade was finished in a stucco mixture of marble dust, cement and sand, was completed in less than six months, attesting to Leonard's claims of the ability of reinforced concrete to provide the investor a completed structure more quickly than any other material. Indeed, after finishing the first floor and mezzanine, the contractor was able to erect the building at the rate of one floor per week.

Leonard's building designs in 1906 also appeared outside San Francisco. In Oakland, he again teamed with McDougall in the design of the Hotel St. Mark. This nine story building of eclectic design provided the engineer with yet another chance to showcase the design and construction possibilities of reinforced concrete. Leonard chose flat slab design with supporting beams between columns in order to facilitate rapid construction. Careful placement of reinforcing provided all-important monolithic continuity to the structure. As in the MacDonough Estate Building, once construction reached the second floor it proceeded at the rate of one floor per week, all concrete work being completed in just 98 working days. Leonard also successfully handled such design difficulties as a spiral stairway to the basement and a circular stairway to the orchestra balcony, both executed in reinforced concrete. The building, whose reinforced concrete construction was selected as a result of the earthquake and fire in San Francisco, was hailed as combining "...aesthetic appearance and excellence of design with stability of construction."

In Salinas, the owners of the Ford and Sanborn Department Store chose Leonard to design a building to replace their earthquake-damaged store. Thus in 1907 Leonard executed the first of a series of role reversals involving himself and the architectural profession when he retained architect Charles W. Dickey as a consulting architect for the commission. The building was designed by Leonard, and its straightforward, unornamented use of reinforced concrete exterior and unobstructed, spacious interior marks an early awareness of the potential of the material to express its own characteristics. The unadorned, planar surfaced, broken only by the broad display windows marks a design well ahead of its time, presaging the International Style. With the design firmly credited to Leonard, Dickey's involvement remains speculative, but may have been merely to avoid any complications with California's architectural licensing law.

This period saw Leonard quickly reach the forefront of his profession in the field of reinforced concrete in California. A foreword to one of his articles termed him "...the coast's foremost authority on reinforced concrete construction," concluding "Mr. Leonard needs no further introduction." In these years Leonard's influence was reflected in his employment of young engineering graduates from the University of California, men who were to use the skills and experience gained under Leonard's tutorage to found their own important engineering careers. From this position of leadership, then, Leonard determined to continue to work to solve problems of design and inspection which threatened to undermine the progress made to date in gaining acceptance of reinforced concrete. The aspects of proper design and adequate inspection were inextricably twined, and no one was more aware of this than Leonard. Where he had previously used articles and editorials to extol the virtues of reinforced concrete from the standpoints of fire resistance, cost, availability and timeliness, Leonard now turned his articles to more technical facets of reinforced concrete engineering. In turn, his editorials swung from calling for ordinance amendment to a plea for better inspection.

In June 1906 Leonard delivered a paper before the Structural Association. The work focused on the proper design of reinforced concrete frame buildings, which Leonard defined as being constructed of slabs, beams, girders and columns, the whole being enclosed by curtain walls supported by the columns. Ever aware of the battle against high initial cost faced by reinforced concrete proponents, he recommended regular arrangement of the frame elements as a means of decreasing labor and construction costs. Aware also that every reinforced concrete failure acted to delay complete acceptance of the still-new material, Leonard stressed the need for proper reinforcement to provide all-important structural continuity, noting: "Many who are designing work of this character are sometimes reluctant to do this because of the increased expense and an improper appreciation of its importance. A vast amount of faulty work can be directly attributed to the omission of this important detail." Indeed, Leonard deemed the subject of proper reinforcement so important that he devoted an entire article to it, seeking to show the need to balance adequate design with the considerations of economy.

But while Leonard wrote of proper design methods, the demand by investors for reinforced concrete structures resulted in many designers and contractors undertaking work for which they had neither educational nor experiential qualifications. Thus, the very period which should have seen the greatest success in the acceptance of reinforced concrete instead saw a rash of structural failures which set development back, according to one estimate, almost two years.

Perhaps the most publicized failure in California occurred on November 9, 1906 when the Bixby Hotel, then under construction at Long Beach and billed as one of the world's largest reinforced concrete buildings, partially collapsed during the pouring of the roof, killing a number of workers. Public outcry was great, and immediately the ruins were set upon by teams of inspectors, with opponents of reinforced concrete attempting to prove the material itself at fault, while proponents worked to show the flaw lay in design or execution. Leonard was among the first on the scene, probably sent as a representative of Architect and Engineer of California. After consulting plans, probing the wreckage and interviewing survivors, he concluded the contractor had erred in the construction and removal of the formwork of previously poured sections of the building, as well as in the placing of reinforcement and pouring of the concrete. These factors had combined to produce a building lacking structural continuity, so that the weight of the wet concrete of the roof caused the fourth floor beneath to fail and collapse through to the third floor, which in turn failed. By the time the collapse ended, some elements of the upper floors were to be found in the basement. Leonard's findings absolved architects Austin and Brown of any blame and supported his published design theories. His conclusions were supported by others, which he made sure saw publication in Architect and Engineer of California. Architect Charles Whittlesey placed additional blame on inexperienced engineers, and was supported in this finding by an editorial probably penned by Leonard. Another architect, Otto H. Neher, attributed lack of continuity to the use of hollow tile curtain walls and ceilings, noting correctly that the proper use of reinforced concrete in these elements would have provided greater strength. Engineer Louis A. Hicks, who inspected the building with contractor Carl Leonardt, found beams, columns and floors had been poured separately, frustrating any designed continuity. They termed it "Mongrel construction." Joseph Simons represented the brick industry in opposition, contending that "...experienced engineers and architects were carried off their feet by the tidal wave (of enthusiasm for reinforced concrete) and are today firm believers in the theory that something can be made out of nothing--that to insert a few iron bars that are not even tied or welded together in a concrete column or girder is a mysterious wonder." Having thus demonstrated his lack of knowledge of reinforced concrete engineering, Simons then concluded, "...the concrete was good, the steel was good, and the design was wholly in the bounds of reinforced concrete engineering practice." The cause, according to Simons, was a flaw in the material itself and hence in its engineering: he claimed the outer walls dried faster than interior columns and girders, with resultant uneven shrinkage and eventual building failure. However, a team composed of engineer T.E. Keough and architects Henry A. Schulze and William Koenig refuted this finding, terming Simons' report for the Bricklayers and Masons International Union an "...attempt to deceive the public..." Like other architects and engineers, they placed the blame on the contractor. Leonard had marshalled his editorial forces wisely, and once again the brick men had underestimated the strength of their opponent. Indeed, Leonard turned the disaster to positive use by utilizing it to support his call for proper design and execution of reinforced concrete construction.

Still, the fact remained that reinforced concrete failures hurt the material in the eyes of the public, and led to editorial call for reform. Noting the hurried reconstruction work in San Francisco had resulted in some poor reinforced concrete work, the editorial charged architects to retain competent engineers. It astutely pointed out that "...a poorly built structure is a menace to the community in more particulars than one, and unless drastic measures are taken to prevent failures, concrete construction will receive a set back from which it will be no easy matter to recover." The editorial then concluded with the suggestion to appoint "...a committee to inspect all reinforced concrete buildings under construction in San Francisco. Leonard's friend Derleth continued to support this position also. Noting the recent rash of reinforced concrete failures in different parts of the country, Derleth placed the blame on human failure--use of reinforced concrete in inappropriate applications, design defects, improper field construction methods, lack of inspection--and called for better engineering, and more and better inspectors, echoing Leonard's earlier pleas for municipal inspectors. Clearly, San Francisco's building inspection problem was not yet in hand.

Thus Leonard embarked upon another facet of his consulting career, this time as engineer for the Western Inspection Bureau. Headquartered in room 621 of the Monadnock Building (Leonard's own office was in room 623), the firm handled "Mill, Shop and Field Inspection of Bridge, Building and Shipbuilding Material, Pipe, Boiler-Plate and Railroad Equipment; Chemical and Physical Tests of Iron Steel, Concrete, Re-inforced \sic} Concrete, Brick, Stone and Terra Cotta; Formulae, Analysis and Tests of Aggregate for Concrete Work; Consultation and Approval of Plans and Specifications; Inspection and Superintendence of Construction." In this manner, the firm supplemented understaffed municipal inspection for at least one year, in addition to supplying the various other services advertised. Moreover, this role brought Leonard into contact with still more major architects, making them aware of the engineer's skills and versatility, and reinforcing Leonard's belief of the need for close interaction and cooperation between architect, engineer and contractor.

At this same time, Leonard took advantage of opportunities to speak to architects and other audiences apart from his

San Francisco colleagues. Records of these occasions reveal, once again, the regard with which he was held. Attending the 15th Annual Irrigation Congress in Sacramento in 1907, Leonard was interviewed by the staff of the Sacramento Union, who introduced him to readers as "...one of the best known authorities on the Pacific Coast in reinforced concrete..." Leonard commented during the interview that "...there is today hardly an architect of any prominence in San Francisco or Los Angeles who has not turned out one or more substantial concrete buildings." Acknowledging the occasional failures of reinforced concrete buildings, Leonard noted failures also among steel and brick buildings, and placed the blame for all on violation of design and construction principles rather than on the materials. Returning to his oft-repeated theme of economic advantage, he emphasized that the ingredients necessary to manufacture Portland cement were all found in California, leaving a larger percentage of the construction investment within the state. In 1908 he carried the message of reinforced concrete to Portland, Oregon, speaking there on September 22 to a group of architects, real estate men and property owners. Portland architect Joseph Jacobberger introduced him as "...one of the ablest men of the Coast in the line of building construction." Illustrating his talk with lantern slides, Leonard called for municipal action to create fireproof districts by zoning and building regulations. In December 1910 he travelled to New York City to deliver an address to the 7th Annual Convention of the National Association of Cement Users (forerunner of the American Concrete Institute). On this occasion he recounted the problems faced by architects and engineers attempting to use reinforced concrete in San Francisco prior to the earthquake, the effects of the disaster based on his own experiences and inspections, and the progress made since 1906. Leonard was able to state that by June 30, 1910, permits for 132 reinforced concrete buildings had been issued in San Francisco.

The hiatus in Leonard's bridge work ended in late 1907 as the engineer, his reputation boosted by his building design and publication work, found time again to return to the structures which remained his prime interest. He quickly undertook a number of commissions, designing a pair of bridges which were built in San Luis Obispo in 1909. The same period saw him win a competition for a group of five bridges in Ross, Marin County, and for another bridge in nearby San Anselmo. As at Reno, he used Beaux-Arts detailing to produce bridges quite in keeping with the architecture of what was, even then, an exclusive suburb of San Francisco. It was at this time that he designed the Gianella Bridge, one of only two steel bridges which can be credited to him. As noted in the history of the bridge, his preliminary proposal had been for a concrete bridge. His occasional failure to sell the idea of reinforced concrete bridges was also seen in a stillborn proposal for a three-span arch bridge across the Feather River at Oroville. Initially selected in 1907 and then rejected due to cost, this structure would have employed a 199-foot center span and would have marked Leonard's departure from the filled spandrel arch to the transitional spandrel cross-wall design.

The year 1911 climaxed Leonard's design work with the filled spandrel arch bridge. Fernbridge crosses the Eel River south of Eureka in northwestern California with seven 200-foot spans. Monolithic abutments aid it in withstanding heavy winter runoff and the battering-ram effects of large logs washed away from upstream mills. Similarly, each of the bridge's massive piers is founded on 250 piles and pier cutwaters shaped like ships' prows reduce stream restriction and deflect debris. Since its construction, Fernbridge has met the river on its own terms. In 1955 and 1964, when the Eel and its tributaries destroyed many newer bridges upstream and obliterated entire towns, Fernbridge stood as if an extension of the bedrock itself. Indeed, during the 1964 floods, water level was almost up to the deck and a large jam of debris lodged against the upstream side of the structure. With the bridge vibrating from the current and from repeated blows of debris, workers resorted to dynamiting the jam. Fernbridge survived both debris and dynamite, and continues to carry traffic today. It has been designated a National Historic Civil Engineering Landmark by the American Society of Civil Engineers.

While Leonard had convinced county officials to sponsor reinforced concrete highway bridges, other bridge applications remained relatively rare. But in 1911 he completed a reinforced concrete railroad bridges across the American River in the Sierras for the Mountain Quarries Company. The structure, designed to carry the largest locomotives of the day as well as cars laden with limestone, is composed of three 140-foot spans towering above the river. Due to the engineering difficulties inherent in the restricted canyon site, the bridge had to be skewed rather than crossing the stream at the preferred right angle. Leonard met the requirement with a bridge that proved to be fully twenty percent cheaper than a steel structure designed for the same site. Like Fernbridge, the Mountain Quarries Bridge was designed for permanence. With its tracks removed during World War II, the bridge has stood unmaintained in quiet abandonment. Yet, in the 1950s and 1960s, it was twice pressed into emergency service as a vehicular bridge when floods washed out highway bridges a few hundred yards upstream.

Also in 1911, Leonard met the requirements of civic officials of the Oakland suburb of Piedmont, who wanted a bridge out of the ordinary. For the second time Leonard retained a consulting architect, this time Oakland architect Albert A. Farr. The collaborative result was a bridge far more architectonic than any other Leonard designed. To the graceful 130-foot arch of Leonard's design, Farr added details to give the town a bridge in the Mission Revival style, then at its height. Tile-roofed pylons at each end of the structure featured ornamental lights, while intermediate kiosks, supported by concrete columns and capped "...in the regulation manner with Spanish S tile..." provided shelter for pedestrians. Corbelled arches carried sidewalks along the bridge's flanks.

In 1913 Leonard and junior partner W.P. Day published The Concrete Bridge. In it they reiterated all of Leonard's arguments for concrete bridges and invited inquiries from their readers. In addition to economy and strength, the book stressed other qualities which served to make the reinforced concrete bridge desirable. Aesthetically, it offered "...conformity with environment...pleasing outline and appropriate use of ornament..." And beautiful bridges, Leonard wrote, "...are a sure indication of a progressive community." The use of California products--cement, sand, gravel and reinforcing steel--negated the often-lengthy wait for Eastern materials associated with steel bridges. Of course, Leonard also addressed the need for careful and competent design. Profusely illustrating Leonard's bridges, and in the tradition of a builder's catalog, the book represented a unique step for a consulting engineer to have taken and underscores Leonard's drive and salesmanship for his products and services.

Experimentation in reinforced concrete bridge design continued into the second decade of the 20th century. Individuals and firms in large numbers applied for patents, reflected in the monthly listings published in Concrete-Cement Age during this period. It appears that Leonard may have been among the applicants. Though his name is not mentioned in theConcrete-Cement Age lists, two accounts credit him with the patenting of a bridge type which he termed "Canticrete." As discussed earlier, a factor working against reinforced concrete structures was high initial cost. Chief among the causes of this high cost was labor. Reinforced concrete bridges, particularly arch bridges, required extensive falsework to support the forms and structure during the pouring of the concrete. The construction of the wooden falsework was labor-intensive, adding to the expense of the reinforcing and concrete work. Secondly, material costs were a direct function of bridge size and design. Therefore, a reinforced concrete bridge requiring less falsework and fewer materials should have been a more saleable product. This appears to have been Leonard's theory in the design of the "Canticrete" bridge.

Essentially, the "Canticrete" bridge utilized a cantilever steel truss to provide sidewall and floor substructure. Steel reinforcing bars were placed following erection of the truss and the entire structure was then encased in concrete. The cantilever was self-supporting during construction, keeping falsework and its attendant costs to a minimum. Due to the strength of the truss, less reinforcing steel was required, and sidewalls and floor could be thinner in section, using less concrete. Given Leonard's education and early training in steel engineering, the solution is not surprising. A "Canticrete design provided a hybrid bridge which employed reinforced concrete to completely encase and protect the steel structure, in the process negating the usual high maintenance costs, as well as reducing labor and materials costs.

The "Canticrete" idea was neither new nor, perhaps, Leonard's alone. The Melan system, developed in Austria ca. 1893, had used I-beams as arch reinforcement. Melan claimed this reduced the amount of reinforcing iron needed, advanced strength and simplified construction. And in 1916 George Hool and Frank Thiessen published Reinforced Concrete Construction, illustrating a girder-type reinforced concrete bridge in which the reinforcement took the form of a truss. The truss was said to be sufficient for carrying both dead and construction loads, which was precisely the theory of "Canticrete." Whether "Canticrete" provided the basis for the Hool and Thiessen depiction or whether theirs was simply a case of parallel development is unknown. However, Leonard was building "Canticrete" bridges at least two years earlier and probably was working on the design ca. 1912.

Records indicate that Leonard designed at least eleven "Canticrete" bridges between 1914 and 1921. Of this number, only three remain, one each in Monterey, Yuba and Stanislaus counties. The Tuolumne River Bridge in Modesto, built in 1917 and known locally as the "Lion Bridge," was one of the largest "Canticrete" bridges and was one for which Leonard again involved a consulting architect, this time Fay Spangler of San Francisco. While Leonard gave Modesto a monumental "Canticrete" bridge, Spangler provided such details as the cast concrete reclining lions which give the bridge its local name, as well as recessed seating areas and ornate light fixtures.

After 1921, Leonard returned to more conventional reinforced concrete bridge designs. Precisely why he abandoned the "Canticrete" type remains unknown, but the likely reason was the very expense which the design was intended to suppress. The cost of skilled labor required to erect the truss would have offset the falsework savings, while expenditures for heavy steel members outweighed the gains achieved through the use of less reinforcing and concrete. Thus the "Canticrete" bridge was in reality no less expensive, in its initial costs, than any other reinforced concrete bridge type, which once again placed the burden of its acceptance on the argument of lower overall maintenance and longer life. The low number of surviving examples is easier to explain. The trussed sidewalls make the type virtually impossible to widen. Thus when traffic volume has exceeded capacity, the only choice has been to replace the "Canticrete" bridge. Nonetheless, through the "Canticrete" design Leonard acknowledged one of the initial drawbacks facing reinforced concrete bridges, and provided an innovative transition in their development.

As the "Canticrete" years wound to a close, Leonard undertook yet another project which was to have great impact on California transportation. Aware of tests proposed in Illinois and Virginia by the U.S. Bureau of Public Roads, Leonard approached W.E. Creed, President of Columbia Steel Company at Pittsburg, California. Leonard proposed to build a concrete test highway to study types and thicknesses of concrete surfaces, reinforcement and adobe soil subgrades peculiar to California. Creed, who believed his company could supply a special open hearth reinforcing steel for highway use, agreed, placing the project in the hands of Leonard and highway engineer Lloyd Aldrich. Creed's only instructions were to make the tests thorough and to collect all appropriate data. Prior to undertaking design and construction, the two sent questionnaires to State and Federal highway engineers, developing the design from their responses. The result was a 1,371-foot oval, 18 feet wide, utilizing 13 sections of various types of concrete pavements. Initially the only direct government involvement was the supplying, by the State, of 40 war surplus trucks. Four tunnels under the track contained instrumentation devised by Leonard to record slab flexure. The entire surface of the highway was marked off into six-foot squares, numbered and lettered to allow precise charting of slab failure. In practice, 20 trucks were driven simultaneously in each direction under gradually increasing loads; speeds were not great, averaging the eight to 12 miles per hour typical of highway truck traffic of the period. Ditches paralleling the road were flooded to study the effect of moisture on the adobe subgrade and its bearing strength under traffic loads. Floodlights allowed the tests to continue after dark. By the time the tests ended in 1922 after two seasons, the trucks had rolled the equivalent of 80 continuous days, subjecting the highway to an accumulated load of 7.36 million tons. The results of the test were provided to the California Department of Public Works in an exhaustive illustrated report. The agency put the data to immediate use, and Leonard's project is credited with giving California's highway program its first great impetus on its way to becoming, by the 1960s, the acknowledged finest such system in the world.

Between 1921 and 1926 Leonard prepared designs for at least nine bridges, of which six were built between 1922 and 1925. In 1921 he designed a three-span open spandrel arch bridge to cross the Russian River at Healdsburg, marking his first use of the fully open spandrel type. But after lengthy meetings in Sacramento with State bridge engineers to discuss design calculations, Leonard and junior partner Harold B. Hammill saw the proposal die of an old cause. County officials opted to build a steel truss bridge instead, choosing the apparent economy of lower initial cost. Leonard's three-span open spandrel design for the American River at Chili Bar near Placerville in the Sierras as that same year achieved construction. With its longest span measuring only 114 feet, the Chili Bar Bridge was not noteworthy in terms of scale. Yet the open spandrel design, lighter in feeling than that of the earlier bridges, represented a refinement of the aesthetics long espoused by Leonard.

At about this time Humboldt County officials embarked on a program to improve the road between Fortuna and Red Bluff. With massive Fernbridge a daily reminder of Leonard's design abilities, they turned to him once again for a series of five bridges in the rugged Van Duzen River canyon. The first two were built in 1922 at Upper and Lower Blue Slide. Two-span open spandrel arches, they had span lengths of 207 feet. Like the Chili Bar Bridge, these structures traversed their setting gracefully, respecting it without overwhelming it, recalling Leonard's notion of "conformity with environment." The fine proportions seen in all of Leonard's designs reached maturity here. Leonard built the remaining bridges over the Van Duzen in 1925. One, the farthest east at Bridgeville, was a single span open spandrel arch replacing an 1880s covered bridge. The other two, however, were totally unique among all of Leonard's designs. These were the bridges erected at the Upper and Lower Blackburn Grade Cutoff. With the road virtually at river level at these points of crossing, the use of a deck arch was not practicable. Such a design would have meant arching the deck to allow sufficient stream clearance and flow beneath the bridge. This in turn would have produced an unacceptable vertical curve in the deck resulting in lack of sight distance for the motorist--a hazardous situation. Leonard thus chose a design which carried the roadway between gracefully soaring arch ribs. Instead of being supported from below, the deck was suspended from the arch above. Again, the engineer provided a suitable engineering solution while meeting his principles of bridge aesthetics.

Finally, in the mid-1920s we find indications of Leonard's last known bridge venture, a proposal for a San Francisco to Alameda transbay structure. The 1926 hearings involving civic leaders of San Francisco and several East Bay cities, as well as governmental and local engineers, considered various proposals to span the Bay. Leonard proposed a bridge linking Hunter's Point in San Francisco with Webster Street in Alameda. His design provided for a double deck, high level crossing to carry a 60-foot roadway and four railway tracks. Six miles in length, with main channel spans comprised of six 510-foot steel trusses, the bridge was projected to cost $35 million. Hearings and considerations continued through the late 1920s, and ultimately a transbay bridge was built to State design from 1934 to 1937, connecting San Francisco with Oakland.

The mid-1920s were a busy period in Leonard's career. In addition to marking the culmination of his bridge work, the period also saw him return to the position of Associate Editor for Reinforced Concrete for Architect and Engineer in 1924. Now the main thrust of his attention was given over to inspection, with editorials on the subject appearing in 1925 and 1926. Citing accidents in San Francisco and Pasadena, and the effects of the 1925 Santa Barbara earthquake, the editorials concluded that either the operation and enforcement of building laws in California were being wrongly handled or the laws themselves were inadequate to ensure public safety. With regard to San Francisco, editorial investigations led to the conclusion that building inspectors were not using enough care in checking construction operations. To rectify the question of adequacy of the laws, a committee of delegates, including Leonard, from the American Society of Civil Engineers, the American Institute of Architects, the Builders' Exchange and the Industrial Association of San Francisco began work to again revise the San Francisco Building Code. Among the committee's most important recommendations was one which called for the appointment of a chief engineer and a number of assistants to provide proper examination of all plans submitted to the Board of Public Works prior to the issuance of any permits. These engineers would also provide field inspection as necessary. Since the recommendation specifically stated these should be full time positions, the implication was that this phase of inspection in San Francisco was being carried out by part time workers, if at all. The committee also made recommendations concerning inspection practices and called for the appointment of not less than six more general inspectors to be added to the present force, which apparently was still chronically short handed.

Leonard's continuing efforts to improve codes and inspection, as well as his high professional standing, did not go unnoticed. In February 1928 San Francisco City Engineer M.M. O'Shaughnessy sent a letter to Mayor James ("Sunny Jim") Rolph recommending Leonard be appointed the city's chief building inspector. O'Shaughnessy stated, "He ranks highly as a structural engineer." The post had come vacant in late 1927 with the death of incumbent John P. Horgan. Leonard, one of two candidates for the position, had the endorsement of the San Francisco Chapter of the American Institute of Architects, the San Francisco Section of the American Society of Civil Engineers, the Down Town Association and the Builders' Exchange; clearly his actions to build closer relations between architect, engineers and builders were also bearing fruit. Rolph in turn recommended Leonard to the Board of Public Works, on the basis that the city needed a "...first class engineer..." to head the Building Inspection Department. Rolph also noted that building had become an engineering problem and the tremendous growth of San Francisco, with a large number of new steel frame and reinforced concrete buildings, required inspection be placed in the hands of men with the requisite technical knowledge. A delegation of architect, engineers and builders urged the Finance Committee of the Board of Supervisors to appropriate funds sufficient for Leonard's salary ($625 per month). The group told the Committee that a revision of San Francisco's Building Code was again due and that Leonard was the choice to undertake the effort. On May 17, 1928 the Board of Public Works appointed Leonard to the position of Chief Building Inspector, the title later being changed to Superintendent of Building Inspection. Putting his accumulated expertise and theories now to municipal work, Leonard saw to the revision of the San Francisco Building Code, improved and expanded inspection services in spite of a continuing shortage of inspectors and began a survey of dangerous structures in the city. When he retired in August 1934 at age 70, Architect and Engineer noted he had served the city well.

While his retirement years found Leonard generally removed from an active design role, he remained active in an advocacy role, continuing to pursue and support code and inspection improvements and improved interdisciplinary relations. In 1928 he had become involved in a movement to establish a California Uniform Building Code. This was undertaken by the California Development Association (later the California Chamber of Commerce), headed by Arthur Bent of Los Angeles and Frederick Koster of San Francisco plus a committee of six business men equally divided between the northern and southern portions of the state. Representatives of the American Association of Civil Engineers, the American Institute of Architects and the California Association of General Contractors participated also, with committees in each half of the state. The aim was to standardize materials and construction and to foster sound building statewide, and to eliminate the plethora of divergent municipal laws. When the draft was ready in mid-1933, Leonard had become Vice-Chairman of the Executive Committee on Building Code Revision. The following year he was appointed Chairman of the Building Code Committee of the Structural Engineers' Association of Northern California, a group he had helped to found in 1930 to establish high standards for the profession and to seek professional licensing for engineers in California. He continued to hold the Association's post until the Code was ready for adoption in 1937. In retirement he also continued an active role with the Association, serving as President in 1935 and 1936. At the Annual Meeting in 1935 he urged the adoption of measures to bring closer relations between engineers, architects and building officials to benefit the general building industry, and appointed a committee to report on the ways and means of achieving this end. In 1936 former junior partner W.P. Day, now a successful engineer himself, turned to Leonard, appointing him Chief of the Division of Roads-Bridges-Paving for the construction of the Golden Gate International Exposition on Treasure Island. In 1940 the Structural Engineers' Association of Northern California appointed him to their Professional Guidance Committee. Finally we find notice of Leonard's last known work in 1942 when, probably due to a wartime shortage of engineers, he designed buildings for United Engineering Company in Alameda.

John Buck Leonard died in San Francisco on February 16, 1945 at 81 years of age. His legacy includes an oeuvre of 47 known bridges designed throughout California (and Nevada), all but three of which were of reinforced concrete, as well as more than a score of reinforced concrete buildings. His aesthetic precepts, set forth in The Concrete Bridge and in his other writings, had influenced State bridge design, while his test highway work had formed the basis for State highway system development. His was a legacy also of improved building codes and regulations, design principles and interdisciplinary cooperation. He had helped lead California from the traditional building practices and casual regulations of the 19th century into the innovative technology and codified practices of the 20th century.

HISTORY: THE BUILDERS

Bridge builders Cotton Brothers formed their firm in 1891. The partnership consisted of Ernest J. and Charles E. Cotton and J.B. Agassiz. Charles Cotton was a personal friend of John Leonard. Prior to establishment of the firm, Charles worked as Secretary of the California Bridge Company of San Francisco, while Ernest billed himself as a bridge builder. The firm was first advertised in the 1892 Oakland business directory under "Carpenters, Contractors, and Builders." Their offices were initially at 241 Bacon Building, Oakland; later they also opened an office in the Monadnock Building in San Francisco, from which building Leonard also worked. (After Leonard lost his office in the 1906 disaster, he used Cotton Brothers' office in the Bacon Building as temporary quarters.) Their advertisements in the 1907-08 period billed them as general contractors in steel frame and reinforced concrete construction. Directory advertisements for the firm disappeared after 1908, and Ernest's death in 1913 marked the dissolution of the firm.

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