HAER No. CA-137

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Chili Bar Bridge
(South Fork American River Bridge)
Spanning the South Fork of the American River
at State Highway 193
Placerville vicinity
El Dorado County
California

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of the Interior
San Francisco, California 94107

HISTORIC AMERICAN ENGINEERING RECORD

CHILI BAR BRIDGE
(South Fork American River Bridge)

HAER No. CA-137

Location:	Spanning the South Fork of the American River on State Highway 193 at Chili Bar, El Dorado County, California.
UTM:	10.689407.4292749
Quad:	Garden Valley (7.5 minute)
Date of Construction:	1922, railing modified 1953, 1980.
Present Owner:	California Department of Transportation 1120 N Street Sacramento CA 95814
Present Use:	Highway Bridge Scheduled for demolition, 1993
Significance:	The Chili Bar Bridge, determined eligible for the National Register of Historic Places in 1986, is a major work of a significant designer. John B. Leonard was a pioneering proponent of the use of reinforced concrete in California. He designed many of the earliest reinforced concrete arch bridges in the state.
Report Prepared By:	Bonnie Wehle Parks Staff Architectural Historian California Department of Transportation District 3 703 B Street Marysville, California 95901 John W. Snyder, Chief Architectural and Historic Studies California Department of Transportation 1120 N Street Sacramento, California 95814
Date:	January 1993

PART I. DESCRIPTION

The Chili Bar Bridge is a reinforced-concrete, open-spandrel, fixed-arch structure twenty feet wide and 384 feet long overall. The symmetrical bridge consists of seven spans: a mainspan of three arch spans, and two cantilevered approach spans at each end. The elliptical mainspan arches are: 111 feet, 114 feet, and 111 feet, with each consisting of two arch ribs. The arches spring from wing wall abutments on massive piers and spread footings. The approach spans are twelve feet each and rest on concrete double column bents. The bridge originally had massive concrete rails. These were changed to metal beam barrier rails in 1953.

PART II. HISTORICAL INFORMATION

Chili Bar

Chili Bar was named for the Chilean miners who came to a site across the river from this location in the early, placer mining years. When Anglo miners accused the Chilean miners of panning the Anglo tailings at night, the Chileans were escorted across the river and told not to return. Finding excellent diggings at their new location, many of the Chileans stayed until a smallpox epidemic in 1886 wiped out all of those remaining. The area is also distinguished by having the oldest continuously running slate quarry in the state. Originally called Buck's Quarry, it began in 1886. At the time it was one of five slate quarries operating in a two mile wide slate vein that ran through the Mother Lode. Slate from the Quarry was used as shingles, and as boards for making counters and coffins. At the peak of its operation, one hundred workers cut and shaped slabs by hand with chisels and water-powered saws. Oxen pulled the finished slabs twelve miles to the railroad at Shingle Springs for shipment to San Francisco. Closed by World War I, the plant re-opened ten years after the war as Pacific Minerals Company, and began production of crushed slate for asphalt shingles. This operation blasted eleven lateral shafts--over two miles of tunnels--through the slate vein. Quarrying continued until 1966 when legislation made "drift" or tunnel mining prohibitively expensive. In 1979, Placerville Industries sold off the old equipment and erected a new plant which is still in operation.

Chili Bar Bridge

The present bridge at Chili Bar is the fourth one to have been built at this location. The first bridge, a toll bridge built in 1854, by Hulet George replaced his cable-operated ferry. That bridge and its tollhouse were destroyed by the flood of 1862.

Hulet and Ealy George sold the property to Leonard Reeg the next year. Reeg built a covered bridge on the site which he operated as a toll bridge until 1887, when he transferred it to the county. That bridge lasted until the late 1890s. The third bridge was constructed of wood and steel. Henry Lahiff, El Dorado County Surveyor, apparently designed and/or oversaw the building of that structure. About thirty years later, Lahiff was to supervise the construction of its replacement.

In July 1921 the wood and steel bridge was being fitted with falsework preparatory to repair when, after the workers had gone for the day, a truck loaded with lumber, and too heavy for the structure to support, attempted to cross. Two large floor timbers broke under the weight. Repairs were made and the bridge put back in service, but within the week the Board of Supervisors instructed Surveyor Lahiff to prepare plans and specifications for an all steel bridge to replace the wood and steel structure. The plans and specifications were adopted at a special meeting of the Board of Supervisors on August 19, 1921. At that same meeting the supervisors adopted a notice to contractors soliciting bids for the job. They also requested plans and specifications for a concrete bridge, stating that it if was not too much more, they would rather have the structure of concrete.

On September 9 the supervisors reviewed bids for the steel bridge ranging from $11,870 to 14,650. But they also approved plans and specifications, drawn up by John Leonard and Henry Lahiff, for a concrete bridge. The county clerk was instructed to advertise for bids. Meanwhile, the old bridge, still under repair and supported on falsework, was being strengthened enough to last until the new bridge was built. At the next meeting, on September 17 the supervisors rejected all the bids for both the steel and the concrete bridge. They decided they wanted to build the concrete bridge, but that as the cost for construction would be less in the summer months, they would re-advertise in the spring.

The notice to contractors was sent out in early February, 1922, and John Leonard's final plans were accepted by the county on the 17th. The bids opened at the March meeting ranged in price from $30,996 to $24,490. The supervisors awarded the construction contract to the low bidder, John H. May of Napa. It is interesting to note that while in August the supervisors' decision to consider a concrete bridge was predicated on its not costing too much more than the steel version, by March their committment to a concrete structure was such that they were willing to double their budget to accommodate it.

Henry Lahiff was appointed supervisor and inspector for the job. Staking off the site and setting the benchmarks began on Tuesday, April 11 and the contractor estimated that the bridge would be completed early in September 1922. The county's pride in the proposed structure was evidenced by the headline in the *Mountain Democrat* announcing "Work begun on great modern concrete bridge." S.G. Beach and Sons lumber and building materials company also ran a large advertisement, which read like an article, boasting of the quality of the Golden Gate Cement that the contractor had ordered for the job from their company.

Work apparently progressed without incident and on schedule; the newspaper had nothing to report for several months. Then on July 1, a headline in the *Mountain Democrat* read "Big Movie Stunt at Chili Bar Planned." The old bridge was to be blown up by a movie company as part of a holdup scene. The stunt was planned for about August 1 when the river was at its low water mark. The same edition of the paper reported that work on the new bridge was three weeks ahead of schedule. Slow delivery of the lumber for the falsework caused a hindrance but no delay. The piers were in position and the formwork for the north main span was nearly ready to recieve the the concrete. No further mention of the movie stunt was found, but in August the contractor appeared before the Board of Supervisors proposing to remove the old bridge and dispose of the material for $500; perhaps he was referring to the part that remained after the movie blast. Work was still progressing on schedule. One hundred and forty feet of the north approach and spans were complete and work had started on the south end. The falsework for the center span was in place and the south pier was finished. By August 26, the bridge was reported to be fifty percent complete. Lahiff was praised by the board for keepng the work on schedule and within budget. However, although no setbacks had been reported in the newspapers during the preceeding months, in November the contractor requested that the completion date be extended to December 1. The revised schedule was met and the Supervisors went to the site, inspected the completed bridge and unanimously accepted it on December 7. The Georgetown Stage crossed it for the first time the next morning.

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 studied 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 the 19th 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," 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 his editorials; 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 supported his proponency of reinforced concrete. His own writings, and articles by other prominent engineers and architects, chided officials and supported use of the new material. 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. Another editorial 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, the gracefully proportioned arch rings, even in this first example, 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 the view from seats on the main floor below. 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.

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 Ralph Warner Hart's new reinforced concrete Bekins Warehouse. Even conservative Octavius Morgan, a proponent of brick who had endorsed concrete for certain structural uses only, 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, *Architect and Engineer of California* 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 structures--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, the 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, 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 product 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. Amid great public outcry, the ruins were immediately set upon by teams of inspectors. Opponents of reinforced concrete attempted 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 in 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 his bridge work ended in late 1907 as Leonard, 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. During this time he also designed the Gianella Bridge, one of only two steel bridges which can be credited to him; although 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 constructed on 250 piles, while 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 bridge 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 the *Concrete-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. In this country, George Hool and Frank Thiessen published *Reinforced Concrete Construction* in 1916, 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 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, a fact 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 as 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 acknowledged, by the 1960s, as the 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 achieved construction that same year. 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, 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 for the benefit of 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 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.

__Henry Lahiff__

Henry Lahiff was born in Ireland in 1868. He studied surveying and engineering and immigrated to Arizona at age twenty. In Bisbee he was employed by the Copper Queen Mining Company. From Arizona he went to various cities up and down the Pacific coast and to Idaho. In 1892 he was employed by the Thompson Bridge Company of San Francisco. He also worked on the construction Southern Pacific Railroad's large wharf at Santa Monica and served as the engineer in charge of the construction of the Sutro Baths in San Francisco. He worked for several large mining companies in the Mother Lode area before becoming the county surveyor and engineer for El Dorado County. While working for the county, he also engaged in private consulting work.

Eligibility

The Chili Bar Bridge was determined eligible for the National Register of Historic Places in 1986 as part of the California Department of Transportation Bridge Inventory. The bridge is eligible under Criterion C as a major example of a significant designer. John B. Leonard's pioneering reinforced concrete bridge design is characterized by a grace and lightness of feeling that belies the nature its construction material. The Chili Bar Bridge exemplifies these characteristics. It possesses a high degree of integrity of location setting, workmanship, materials, feeling, and association. Its integrity of design is only slightly impaired by the modified railing. The bridge is scheduled for demolition in 1993.

PART III. SOURCES OF INFORMATION

Books

Aldrich, L. and J.B. Leonard. *Report of Highway Research at Pittsburg, California, 1921 and 1922*, n.p.

Byington, L.F. *The History of San Francisco*. 3 vols., Chicago and San Francisco: 1931.

Crocker-Langley San Francisco Business Directory. San Francisco: 1907 and 1908.

Derleth, C., Jr. *The Destructive Extent of the California Earthquake: Its Effect Upon Structures and Structural Materials Within the Earthquake Belt*, San Francisco: 1907.

Dickey, C.W. *The Architectural Work of Charles William Dickey, Architect, Oakland, California*: n.p., 1907.

Historic Civil Engineering Landmarks of Sacramento and Northeastern California. Sacramento: 1976.

Hool, G.A. and F.C. Thiessen. *Reinforced Concrete Construction*. 3 vols., New York: 1916.

Leonard, J.B.. "The Use of Reinforced Concrete in San Francisco Vicinity." in *National Association of Cement Users, Proceedings of the Annual Convention Held at New York, N.Y., December 12, 13, 14, 15, 16, 17, 19, 20, 1910*. VII. R.L. Humphrey (ed.), New York: 1911.

___________ and W.P. Day. *The Concrete Bridge*. San Francisco: 1913.

Oakland, Alameda and *Berkeley City Directory*. San Francisco: 1891, 1892.

Myers, W.A. ed. *Historic Civil Engineering Landmarks of San Francisco and Northern California*. San Francisco: 1977.

Page, Charles Hall & Associates, Inc. *Splendid Survivors*. San Francisco: 1979.

Tinkham, G.H. *History of Stanislaus County*. Los Angeles: 1921.

Turner, P.V. "The Collaborative Design of Stanford University." in *The Founders & The Architects*. Stanford: 1976.

Vandor, P.E. *History of Fresno County*. Los Angeles: 1919.

1913 Oakland-Alameda-Berkeley Directory, Oakland: 1913.

Periodicals

Albright, H. "Reinforced Concrete." *Architect and Engineer of California*. December 1905.

"Am. S.C. Engineers Addressed by Editor." *Architect and Engineer*. July 1937.

"Architects and Engineers." *Architect and Engineer*. November 1942.

Barnes, W.F.. "Concrete from a Brick Man's Standpoint." *Architect and Engineer of California*. September 1906.

"Brickmakers' Opposition to Re-enforced [sic] Concrete." *Architect and Engineer of California*. May 1906.

Business Mosaics." *California Architect and Building News*. March 1897, and June 1897.

Butler, F.M. "Longest Reinforced Concrete Bridge in the United States." *Architect and Engineer of California*. January 1906.

"A California Concrete Bridge in Mission Style." *Concrete-Cement Age*. January 1912.

"Concrete Construction for Bridges." *Architect and Engineer of California*. June 1907.

"Concrete Failures; Must We Have Them?" Architect and Engineer of California. February 1907.

"Concrete in Bridge Building" *Architect and Engineer*. October 1912.

"Concrete Test Highway at Pittsburg." *Architect and Engineer*. January 1922.

"Contracting News." *Engineering Record*. May 19, 1906.

"Convention of Structural Engineers." *Architect and Engineer*. November 1935.

Cottrell, C.C. "The Pittsburg Highway Test" *Motor Land*. March 1922.

____________ "Bridging the San Francisco Bay." *Motorland*. January 1926.

Couchot, M. "How the Earthquake Affected Certain Buildings." *Architect and Engineer of California*, May 1906.

Day, W.P. "Concrete To Be A Factor In Rebuilding." *Architect and Engineer of California*. July 1906.

____________ "Oakland Avenue Reinforced-Concrete Bridge in Piedmont, California." *Engineering News*. September 14, 1911.

____________ "A Reinforced Concrete Railroad Bridge." *Western Engineering*. May 1913.

____________ "Reinforced Concrete Bridges, with Specific Descriptions." *Architect and Engineer*. August 1910.

____________ "The Macdonough [sic] Estate Building." *Architect and Engineer of California*. December 1907.

____________ "The Reno Reinforced Concrete Bridge" *Architect and Engineer of California*. March 1906.

Derleth, C., Jr. "A Year of Reconstruction." *Mining and Scientific Press*. April 20, 1907.

____________ "Reinforced Concrete Tests at the University of California." *Architect and Engineer of California*. February 1906.

____________ "Reinforced Construction; Its Proper Application in Earthquake Countries." *American Builders Review*. May 1907.

____________ "Structural Lessons of the Earthquake Disturbance." *Architect and Engineer of California*. May 1906.

Dickey, C.W.. "Lessons of the San Francisco Earthquake and Fire." *Architect and Engineer of California*. May 1906.

"Discussion by Letter, Cinder Concrete." *Engineering Supplement to American Builders Review*. November 10, 1906.

Duryea, E. letter to Editor of *Engineering News*. August 9, 1906 .

"Engineers' Reports on the California Disaster." *Engineering News*. May 3, 1906.

"Engineers With Bay Exposition." *Architect and Engineer*. February 1936.

"Engineers' 1934 Committees." *Architect and Engineer*. January 1934.

Genzoli, A. "Queen of California Bridges." *The Humboldt Historian*. September-October 1981.

"Give Us Better Inspection." *Architect and Engineer*. February 1926.

Hammill, H.B. "Five Highway Bridges Across the Van Duzen River, California." *Western Construction News*. March 25, 1927.

Hart, R.W. "Bekin Building an Example for Reinforced Concrete Advocates," *Architect and Engineer of California*. May 1906.

____________ "Fireproof Reinforced Concrete Storage Warehouse." *Architect and Engineer of California*. October 1905.

____________ and J.B. Leonard. in "Comments of Californian Engineers on the Earthquake and Fire." *Engineering Record*. May 12, 1906.

"Hear Earthquake Talks." *Architect and Engineer*. February 1936.

Hicks, L.A. "Calls It Mongrel Construction" *Architect and Engineer of California*. November 1906.

____________ "Reinforced Concrete Construction." *Architect and Engineer of California*. September 1905.

"Historic 'Test' Highway Soon to Belong to Past." *California Highways and Public Works*. September-October 1928.

Howe and Peters. "Testing Concrete Highway Pavement." *Motor Land*. October 1921.

"Informal Discussion, Committee on Reinforced Concrete." *Engineering Supplement to American Builders Review*. June 30, 1906.

Keough, T.E. "Failure of the Bixby Hotel." *Architect and Engineer of California*. December 1906.

"Leonard Has High Rating." *Architect and Engineer*. October 1928.

Leonard, J.B. "A California Uniform Building Code." Architect and Engineer. April 1928.

____________ "Cost of Concrete Construction." *Architect and Engineer of California*. August 1908.

____________ "The Effect of the California Earthquake on Reinforced Concrete." *Engineering Record*. May 26, 1906.

____________ "The Failure of the Bixby Hotel." *Architect and Engineer of California*. November 1906.

____________ "How Reinforced Concrete Stood Earthquake and Fire." *Architect and Engineer of California*. May 1906.

____________ "Reconstruction of the Car Ferry Transfer Aprons at Port Costa and Benicia." *Transactions of the Technical Society of the Pacific Coast*. 1895.

____________ "Reinforced Concrete Floor Construction." *Architect and Engineer of California*. February 1908.

____________ "Reinforced Concrete Frame Construction." *Architect and Engineer of California*. June 1906.

____________ "Reinforcing Concrete." *Architect andEngineer of California*. October 1906.

____________ "Specifications for Reinforced Concrete." *Architect and Engineer of California*. August 1905.

McMullin, N. "Reno's Virginia Street Bridge: Its Historic and Engineering Significance." *Washoe Rambler*. Summer 1981.

Morgan, O. "A Los Angeles Architect's Impressions of the San Francisco Earthquake and Fire." *Architect and Engineer of California*. May 1906.

____________ "Will Not Supplant Stone or Brick." *Architect and Engineer of California*. December 1905.

Neher, O. "Blames Hollow Tile Walls." *Architect and Engineer of California*. November 1906.

"New Building Inspector." *Architect and Engineer*. August 1934.

"Personals." *Architect and Engineer*. June 1928.

Panhorst, F.W. "Century of Bridge Progress." *California Highways and Public Works*. Centennial Edition. September

"Partial Collapse of the Bixby Hotel at Long Beach." *Architect and Engineer of California*. November 1906.

"Personals." *Architect and Engineer*. June 1928.

"Popularity of Reinforced Concrete in San Francisco." *Architect and Engineer of California*. September 1907.

"Prospectus." *Structural Association of San Francisco Weekly Bulletin*. June 23, 1906.
9, 1950.

Pursell, C.W., Jr. "The Technical Society of the Pacific Coast, 1884-1914." *Technology ard Culture*. October 1976.

""Reinforced Concrete." *Architect and Engineer of California*. August 1905.

"Reinforced Concrete in the New City." *Architect and Engineer of California*. May 1906.

"Reinforced Concrete on the Pacific Coast." *Architect and Engineer of California*. February 1906.

"Reinforcement in Pollasky Bridge." *Architect and Engineer of California*. February 1906.

Simons, J. "The Bixby Hotel Disaster as Viewed by a Brick Man." *Architect and Engineer of California*. December 1906, 51-52.

Snyder, J.W. "The Bridges of John B. Leonard, 1905-1925." *Concrete International*. June 1984.

____________ "Bridges and Buildings for the 20th Century." *California History*. Winter 1984.

"Some Features of the New Building Laws of San Francisco."*Architect and Engineer*. December 1909.

Soule, E.L. "A Reinforced Concrete Hotel Building in Oakland, Cal." *Engineering Record*, December 21, 1907.

"Sparks From The Fire," *Architect and Engineer of California*. May 1906.

"Structural Association of San Francisco." *Architect and Engineer of California*. June 1906.

"Structural Engineers In War Work." *Architect and Engineer*. April 1943.

"Structural Engineers' 1940 Workers." *Architect and Engineer*. February 1940.

"Talks on Fireproof Construction." *Architect and Engineer of California*. October 1908.

"The Hotel St. Mark, " *American Builders Review*. November 1906.

"The New Building Ordinances." *Architect and Engineer of California*. July 1906.

"The Road Test at Pittsburg." *Motor Land*. November 1921.

"The San Francisco Bay Bridge Project." *Architect and Engineer*, February 1926.

"The Structural Association of San Francisco." *American Builders Review*. August 1906.

"Transcript of Notes." *Engineering Supplement to American Builders Review*. October 13, 1906.

"Uniform Building Code." *Architect and Engineer*. August 1933.

Whitmore, V. "Stanislaus' Roads" *The California Motorist*. July 1918.

Whittlesey, C.F. "California's Largest Reinforced Concrete Building" *Architect and Engineer of California*. March 1906.

____________ "Concrete Construction." *Architect and Engineer of California*. December 1905.

____________ "Victory For Pure Type of Reinforced Concrete." *Architect and Engineer of California*. November 1906.

"Wish Surveys Continued." *Architect and Engineer*. January 1934.

"Work of the Healy-Tibbits [sic] Construction Company. *Architect and Engineer of California*. October 1908.

Newspapers

"A Modern Concrete Bridge." adv. *Mountain Democrat*. Mar. 11, 1922, 8:2.

"Accepts New Chili Bar Bridge." *Mountain Democrat*. Dec. 4, 1922, 1:1.

"Big Movie Stunt at Chili Bar Planned." *Mountain Democrat*. July 1, 1922, 1:3.

"Board of Supervisors." *Mountain Democrat*. Aug. 6, 20, Sept. 10, 24, 1921, Feb. 11, Mar. 11, June 10, Aug. 12, 1922.

"Board of Supervisors June Session." *El Dorado Republican*. June 9, 1922, 2:3.

"Bridge Engineer Opposes Tube in Transbay Plans." San Francisco *Chronicle*. August 6, 1926.

"Chili Bar Bridge Broken." *El Dorado Republican*. July 29, 1921, 6:4.

"Chili Bar Bridge is Fifty Per Cent Done." *Mountain Democrat*. Aug. 26, 1922, 1:1.

"Chili Bar Bridge Work." *Mountain Democrat*. July 1, 1922, 1:4.

"Concrete Bridge at Chili Bar." *El Dorado Republican*. September 9, 1921, 4:2.

"Concrete Bridge for Chili Bar Crossing." *El Dorado Republican*. February 17, 1922, 6:3.

"County Supervisors." *El Dorado Republican. September 16, 1921, 6:5.*

"Engineers Plan For The New City--Important Meeting in Ferry Building--Construction Methods Discussed." San Francisco *Chronicle*. May 18, 1906.

Galloway, J.D., C.H. Snyder, L.A. Hicks, L.E. Hunt, J.B. Leonard, F.S. Edinger, Hoyt; C. Derleth, Jr. "Notice to Structural Engineers." San Francisco *Chronicle*. May 11, 1906.

Gray, T. "Save Old Bridge--And $800,000?." Modesto *Bee*. June 16, 1980, A-1.

"J.B. Leonard Boosted For Horgan's Post." San Francisco *Chronicle*, March 17, 1928, 5.

"Leonard Urged As Inspector." San Francisco *Chronicle*. February 10, 1928, 10.

"Leonard's Job Unaffected by Supervisors." San Francisco *Chronicle*, May 23, 1928.

"New Bridge Planned at Chili Bar." *El Dorado Republican*. August 5, 1921, 1:2.

"Proceedings of the Board of Supervisors." *Mountain Democrat*. Nov. 18, 1922, 1:1.

"S.F. Engineer Takes Office." San Francisco *Chronicle*. May 18, 1928, 4.

"Special Meeting of County Supervisors." *El Dorado Republican*. August 19, 1921, 3:3.

"Storm Washes Out the Bridge at Chili Bar." *El Dorado Republican*. November 10, 1922, 3:3.

"Structural Engineers Name Sub-Committees." San Francisco *Chronicle*, May 27, 1906.

"Supervisors Accept Bridge." *El Dorado Republican*. December 8, 1922, 5:4.

"Suprevisors' Report." *El Dorado Republican.* March 10, 1922, 1:4.

"The Chili Bar Bridge." *El Dorado Republican.* October 7, 1921, 1:5.

"Work Begins on the New Chili Bar Bridge." *El Dorado Republican.* April 14, 1922, 6:5.

"Work Begun on Great Modern Concrete Bridge." *Mountain Democrat.* Ap. 15, 1922, 1:1.

"Work Progressing on Bridge." *El Dorado Republican.* August 25, 1922, 1:6.

Manuscripts

Barnes, D.A. "Highway Research Conducted at Pittsburg, California in The Years Of 1921 and 1922." University of California, Berkeley, November 3, 1924.

"Bridge Report, S. Fk. American River (Chili Bar)." California Department of Transportation, Sacramento, July 31, 1939.

Brown, F.R. "Bridge Report, San Joaquin River (Friant)." California Department of Transportation, Sacramento, February 1934.

Derleth, C., Jr. Berkeley, California, to J.B. Leonard, San Francisco, California, April 30, 1906. L.S., Charles Derleth, Jr. Manuscripts, Part II, Volume II. Bancroft Library, University of California, Berkeley.

____________ "Buildings of Reinforced Concrete," paper read at the 34th Annual Meeting of the Fire Underwriters Association of the Pacific, January 11-12, 1910. Charles Derleth, Jr. Manuscripts, Bancroft Library, University of California, Berkeley.

"Historical Property Survey Report for the Proposed Replacement of the Honcut Road Bridge on Honcut Creek, Yuba County, California." Yuba County Department of Public Works, Marysville, California, n.d.

Jones, W.P. "Final Construction Report of a Reinforced ConcreteGirder Bridge constructed across the San Joaquin River in the Counties of Fresno and Madera at Friant on road VI-Fre, Mad-FAS 560, Contract 52-14DC10." California Department of Transportation, Sacramento, October 9, 1952.

Leonard, J.B. "A Memory Outline of the Pioneer Leonard Family of Union City, Michigan." October 2, 1941. A copy of this manuscript was furnished to the author by Gary Knecht, Oakland, California.

____________ Oakland, California, to C. Derleth, Jr., Berkeley, California, May 1, 1906. L.S., Charles Derleth, Jr. Manuscripts, Part II, Volume II. Bancroft Library, University of California, Berkeley.

____________ San Francisco, California, to L.H. Taylor, Hazen, Nevada, March 8, 1905. L.S., Truckee-Carson Irrigation Project Records, Nevada Historical Society, Reno.

____________ San Francisco, California, to L.H. Taylor, Hazen, Nevada, May 23, 1905. L.S., Truckee-Carson Irrigation Project Records, Nevada Historical Society, Reno.

____________ San Francisco, California, to S.K. Lindley, Los Angeles, California. n.d., L.S. A copy of the letter, as printed in the Union City, Michigan newspaper in 1906 was furnished to the author by Gary Knecht, Oakland, California.

Poppe, C.R. and Trask, J.W. "Final Construction Report of a bridge reconstructed across the Stanislaus River in the Counties of Stanislaus and San Joaquin near Ripon on road X-SJ-4-A, Contract 411TC21," California Department of Transportation, Sacramento, February 14, 1934.

Pursell, C. Historic American Engineering Record Inventory Cards for the five Ross Bridges. completed for the Department of the Interior, September 1979, California Department of Transportation, Sacramento and California Office of Historic Preservation, Sacramento.

Snyder, J.W. "An Evaluation of Van Duzen River Bridge on 01-Hum-36, P.M. 13.86," California Department of Transportation, Sacramento, November 9, 1979.

____________ "An Historical/Architectural Evaluation of Dry Creek Bridge on 10-Sta-132, P.M. 15.64." California Department of Tranportation, Sacramento, August 1979.

____________ "Historic American Engineering Record, Gianella Bridge, California State Highway 32 at Sacramento River, Glenn and Butte Counties, California." California Department of Transportation, Sacramento. n.d.

____________ "Report on Gianella Bridge on 03-But-32, P.M. 0.00, Sacramento River." California Department of Transportation, Sacramento, December 1, 1977.

Wooldridge, Major Jesse Walton. *History of the Sacramento Valley, California*. Chicago: The Pioneer Historical Publishing Company, 1931.

Interviews

Harold B. Hammill at his home in Rossmoor, California, January 17, 1981. Mr. Hammill worked for Leonard in the 1920s.

Nanita Hutton at her home in Rossmoor, California, May 1, 1981. Mrs. Hutton is Leonard's adopted daughter.

Kimberley Gresham, Monterey County Historical Society, By Telephone, November 2, 1981.