Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 73/1/73/2 (1995)

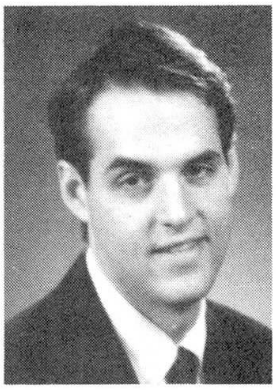
Artikel: Renovation of Seattle's historic Paramount Theatre
Autor: Lundeen, Terry R. / Harriott, James D.
DOI: https://doi.org/10.5169/seals-55172

Renovation of Seattle's Historic Paramount Theatre
Réhabilitation du théâtre Paramount à Seattle
Renovierung des Paramount Theater in Seattle

Terry R. LUNDEEN
Principal
Coughlin Porter Lundeen, Inc.
Seattle, WA, USA

Terry Lundeen was structural project manager for the Paramount Theatre renovation. His experience over the past 15 years includes design of building structures, both new and renovated. He received his BSCE from Bradley Univ. and his MSCE from the Univ. of Houston.

James D. HARRIOTT
Project Engineer
Ratti Swenson Perbix, Inc.
Seattle, WA, USA



James Harriott was responsible for seismic design on the Paramount Theatre project. He has performed seismic analysis and design for numerous renovations, as well as for new construction. He received his BSCE from the Univ. of Washington and his MSCE from Univ. of California, Berkelev in 1990.

SUMMARY
The Paramount Theatre was built in the later 1920s in Seattle, Washington. Intricately designed by renowned local architect B. Martin Pritica, the 3000 seat theatre has hosted many millions of people over the years. Expectedly, the building has taken a fair amount of wear and tear. Although its beauty has aged gracefully, major renovations have become necessary to pass on the building's legacy to future generations. This paper presents the structural aspects of this renovation, including a major stage expansion, a backstage addition, and a seismic upgrade.

RÉSUMÉ
Le théâtre Paramount à Seattle, Washington, fut construit vers la fin des années vingt. Ce théâtre de 3000 places vit au cours des temps passer des millions de spectateurs. Aussi, les traces d'usure étaient-elles nettement visibles. Malgré un certain charme, son vieillissement a exigé dune profonde rénovation, afin que les générations futures puissent également en profiter. Les travaux de réhabilitation comportent l'agrandissement de la scène principale, l'adjonction d'une arrière-scène et le renforcement des structures contre les effets sismiques.

ZUSAMMENFASSUNG
Das Paramount Theater in Seattle, Washington, wurde in den späten Zwanzigerjahren erbaut. Das Theater hat mit 3000 Plätzen über Jahre hinweg viele Millionen Zuschauer gehabt. Entsprechend deutlich sind die Spuren der Abnutzung. Trotz seiner Schönheit hat die Alterung eine gründliche Renovation für die Uebergabe an zukünftige Generationen nötig werden lassen. Der Beitrag stellt die baulichen Arbeiten des Projekts vor, darunter eine deutliche Vergrösserung der Bühne, die Erweiterung der Hinterbühne und eine Verstärkung gegen Erdbeben.

1. INTRODUCTION

The Paramount Theatre (Figure 1) first opened in 1928 and was hailed by the national press to be the "largest and most beautiful theatre west of Chicago". Since that time, the facility has hosted numerous movies, vaudeville shows, concerts, Broadway performances, and presentations. Entertainment choices have changed dramatically over the past 65 years and the restoration is a response to those changes. The renovation includes a stage expansion that will accommodate the biggest Broadway shows, cleaning and restoration of public areas to bring them to their former glory, installation of state of the art sound and lighting systems, and the opening of new restaurants and clubs is planned. In addition, life safety improvements including seismic retrofit have been completed.

Fig. 1: Paramount Theatre

2. DESCRIPTION OF THE ORIGINAL STRUCTURE

The original building included a theatre and apartment. The theatre, where most of the current restoration is taking place, consists of a steel frame structure of riveted members built-up from plates and angles. The auditorium roof comprises trusses spaced at 6 m on center and free spanning the 36 m wide space. Two plate girders span the proscenium opening, one supporting the masonry fire wall above and the other the downstage portion of the gridiron and roof structure. The upstage portion of the gridiron and roof structure was originally supported on columns spaced at approximately 6 m on center. These columns are typical at the exterior theatre walls and are infilled with unreinforced brick masonry (URM). The interior theatre walls are steel frame infilled with unreinforced clay tile. The nine story apartment tower at the north end of the building is a reinforced concrete structure with pan joist floors, core walls, and exterior frames.

At the onset of the current restoration project, an extensive evaluation of the existing structure was undertaken. Material testing included compression strength of concrete cores, chemical analysis for weldability of steel, and in-place brick shear tests. Existing member sizes were spot checked in the field, and loading capacity of critical members was verified. Additionally, a comprehensive seismic evaluation of the existing structure was completed.

3. STAGE EXPANSION

The primary component of the theatre renovation was the stage expansion to accommodate modern, large performances. The stage width was increased from 23 m to 29 m and the depth was increased from 9 m to 15 m. In order to accomplish this expansion, major demolition of the existing structure was required. The demolition included complete removal of the stage back wall, removal of a two-story area at stage right, and partial removal of five stories of dressing rooms, stairs, and an elevator at stage left.

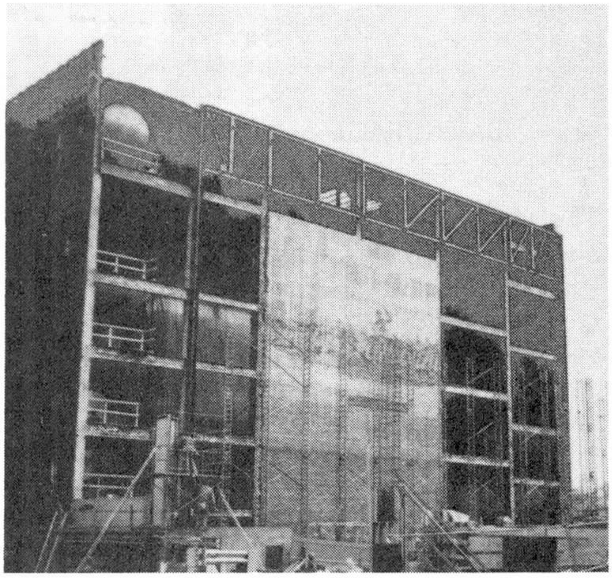


Fig. 2: New Truss

With the necessary removal of the back wall structure, the existing roof structure required new support. New support was provided by installation of a 3 m deep steel truss spanning 27 m over the new stage. The new truss can be seen in Figure 2. This photo was taken prior to demolition of the rear wall and existing columns.

Another important improvement during this renovation was the modification of the rigging arrangement. Originally, the stage rigging system was mounted to the gridiron 21 m above the stage and 3 m below the roof. This arrangement created a congested web of loft lines at the gridiron, making access to spot lines very difficult. In modern theatres, rigging consists of loft lines pulled vertically through sheaves which are attached to roof beams and hemp lines which thread through pulleys mounted on the gridiron. The loft lines support scenery and are spaced at 20 cm on center upstage and downstage and spaced at 3 m on center side to side. The loft lines are collected on the head block at stage right and then drop down to a counterbalance pit below stage level. The hemp lines support spot loads on the stage and pass through hemp head beams on each side of the gridiron. A plan view of the gridiron showing major elements is given in Figure 3.

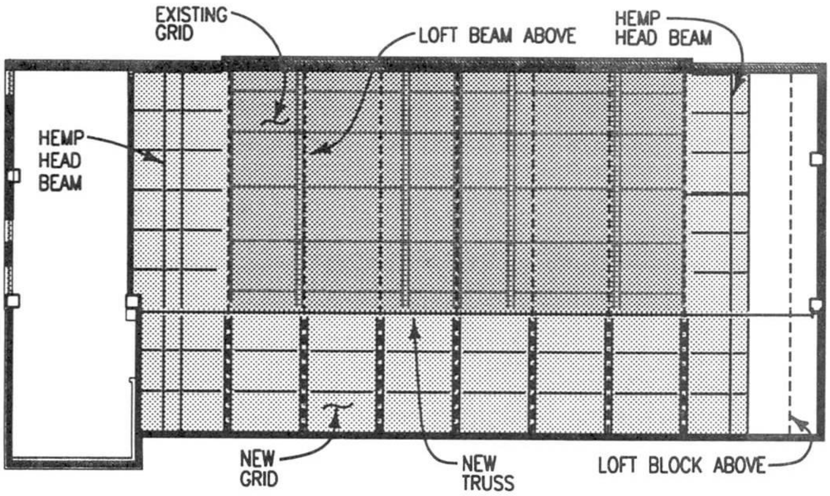


Fig. 3: Major Stage Rigging Elements

In general, the original roof and gridiron structure had adequate overall capacity for modern production loads, however, it was not configured for the new arrangement. Complete removal of the stage roof and gridiron structures was considered as an option, but cost and constructability issues dictated that the preferred approach was to modify the existing structure. This modification required careful consideration of sequence and load transfer during construction. A 9 step sequence was developed and was included on the structural drawings. The new elements to be installed included loft beams, head block, new gridiron hanger supports, gridiron grating and beams, hemp head beam, and two counterweight loading areas. The erection sequence allowed for installation of all the new elements without shoring the existing structure.

4. BACKSTAGE ADDITION

The next major component of the renovation was the expansion of the building in the area adjacent to the new stage. This expansion, approximately 9 m by 33 m in plan, included a new transformer vault and electrical room in the basement, a two-truck loading dock at street level, a large 6 m by 9 m freight elevator down to the stage level, a dressing room level, a passenger elevator and exit stair to allow access to 8 existing stage left levels, and a rooftop mechanical area.

A major excavation was required for the basement which was nearly 9 m below grade at some points. As is common for renovation work located in urban locations, this excavation required shoring around the perimeter. The shoring work was particularly challenging because it occurred in a cramped space adjacent to two city streets and a freeway exit ramp. Special tieback regrouting methods were used because of poor soil conditions and obstructions which limited anchor lengths.

The foundation of the new structure consisted of concrete augercast piles in combination with the steel soldier piles, which were attached to the concrete walls for transfer of permanent gravity loads. The loading dock is a cast-in-place concrete structure designed for highway truck loads. The dressing rooms and roof are conventional steel frame floor systems supported on steel tube columns at the exterior and concrete masonry unit (CMU) walls at the backstage wall. This tall slender 19 cm CMU wall also supports a portion of the expanded stage roof. A photograph of the building showing the backstage addition is given in Figure 4.

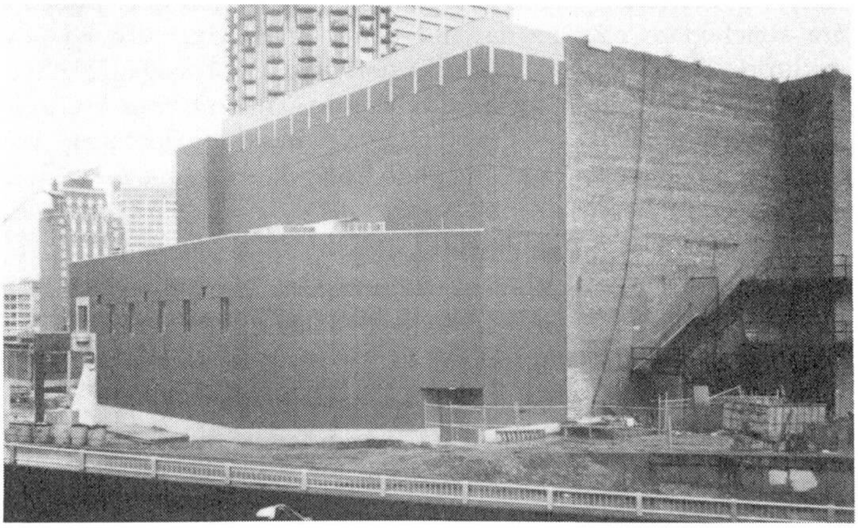


Fig. 4: Backstage Addition

5. SEISMIC UPGRADE

The seismic upgrade of the Paramount Theatre consisted of two main phases. The first step was to make a careful evaluation of the existing structure to identify local seismic hazards such as unbraced parapets and global seismic force resisting system deficiencies such as overstressed masonry walls. The second step was to craft a new lateral system which could supplement the strength of the walls in the existing building, as well as take advantage of the inherent large amounts of new masonry walls in the new addition.

The theatre was evaluated using the methodology of the "NEHRP Handbook for the Seismic Evaluation of Existing Structures," published by the Federal Emergency Management Agency. This handbook is commonly known as FEMA-178 and assists the designer to identify various local hazards in addition to the global lateral force resisting system deficiencies. The force level associated with the FEMA-178 analysis is somewhat lower than that of the UBC and is meant to provide a minimum life safety capacity for the lateral system. From the FEMA-178 evaluation process the following hazards were identified:

- The roof parapets were unbraced unreinforced masonry.
- The span of some URM walls between supporting steel girts or columns was excessive.
- The projection room above the auditorium was an unbraced hanging structure.
- Hollow clay tile walls existed at several locations above the auditorium.
- A weak story condition existed at the theatre lobby / apartment section of the building.
- There was excessive shear demand at the URM proscenium wall.
- There was excessive shear demand at the URM east and west exterior walls.

Providing for the mitigation of the local seismic hazards noted above was fairly straightforward once the hazards were identified. The URM roof parapets were braced to the roof using a traditional framework of angles. In this case, however, the URM was constructed of an open latticework of cast stone. To maintain the historic appearance of the lattice the cast stone was attached to the angle braces via epoxy anchors and chain link fence. Chain link fence was also used to mitigate the hazard of clay tile partitions above the auditorium ceiling. Chain link fence provided a means to control the debris from the expected clay tile failure in a cramped space next to an historic plaster ceiling.

The backstage addition was designed to resist all of the seismic loads resulting from the weight of the new building according to the 1991 Uniform Building Code (UBC). The lateral system in the new addition consists of reinforced masonry and concrete shearwalls. This structure is a stable and complete lateral force resisting system, without incorporating the existing elements. However, the walls in the new addition were also designed to assist the existing masonry walls and mitigate global deficiencies.

For seismic loads in the longitudinal (north/south) direction, the reinforced concrete shear walls in the new addition supplement the east and west URM walls in the existing building. The new concrete walls were tied directly to the balcony structure to transfer the large inertial forces collected in the balcony. These walls were designed for the greater of (1) the shear from the new addition based on the 1991 UBC, or (2) 25% of the shear from the entire building based on FEMA-178. To that extent the concrete walls serve as a back-up to the existing URM walls. The FEMA-178 R factor is 1.5 for unreinforced masonry shearwalls and 4.5 for masonry shearwallls. Due to the back-up reinforced shearwalls and because of the significant tensile capacity of the steel frame structure within the walls, the design of the east and west walls was based on an intermediate R factor of 2.5.

For seismic loads in the transverse (east/west) direction, new reinforced masonry and concrete shearwalls were designed to resist the entire seismic base shear. Since the existing backstage (south) wall was removed to accommodate the stage expansion, the new backstage wall of reinforced masonry was designed to resist the seismic forces from the southern portion of the combined building. A new shotcrete wall was placed against the demising wall between the theatre and apartment tower and was designed to resist seismic forces from the northern portion of the theater as well as the apartment tower. This wall eliminated the weak story condition in that portion of the building. In addition to the two main walls, the proscenium wall was strengthened. This strengthening was designed only to provide some measure of ductility at the proscenium opening. This wall was not designed to carry any of the building seismic forces apart from its own weight.

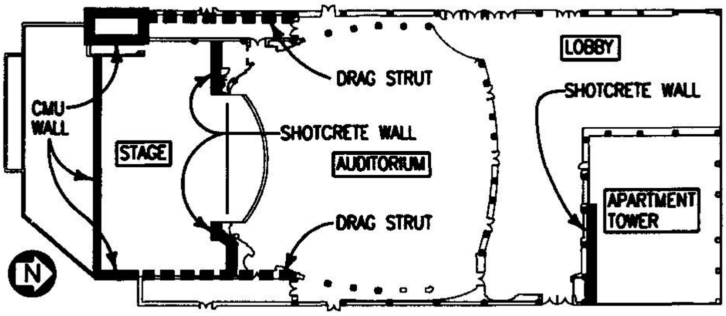


Fig. 5: New Seismic Elements

In summary, the seismic upgrade was designed to achieve two goals. First, the local seismic hazards such as hollow clay tile partitions and walls and unbraced parapets were mitigated. Second, the more serious deficiencies in the global seismic force resisting system were mitigated in a manner which took advantage of the configuration of the new addition as well as the inherent strength in the existing walls. The new concrete shearwalls were located at the walls demising the different functions of the building in order to minimize the impact to the architectural program. A key plan showing major lateral force resisting elements is given in Figure 5.

6. SUMMARY

In conclusion, the renovation of the Paramount Theatre was a challenging endeavor for the owners, contractors, architects, and engineers alike. With the motivation of a deadline for the opening of a major Broadway show, the construction was successfully completed at budget in an aggressive six month schedule. The load-in and rehearsals for Miss Saigon began in late January with opening night scheduled for March 17, 1995. In an era where many of the old theatres in the United States have been demolished, the perseverance of the owners and the skill and ingenuity of the design and construction team has revitalized a Seattle landmark for many years to come.