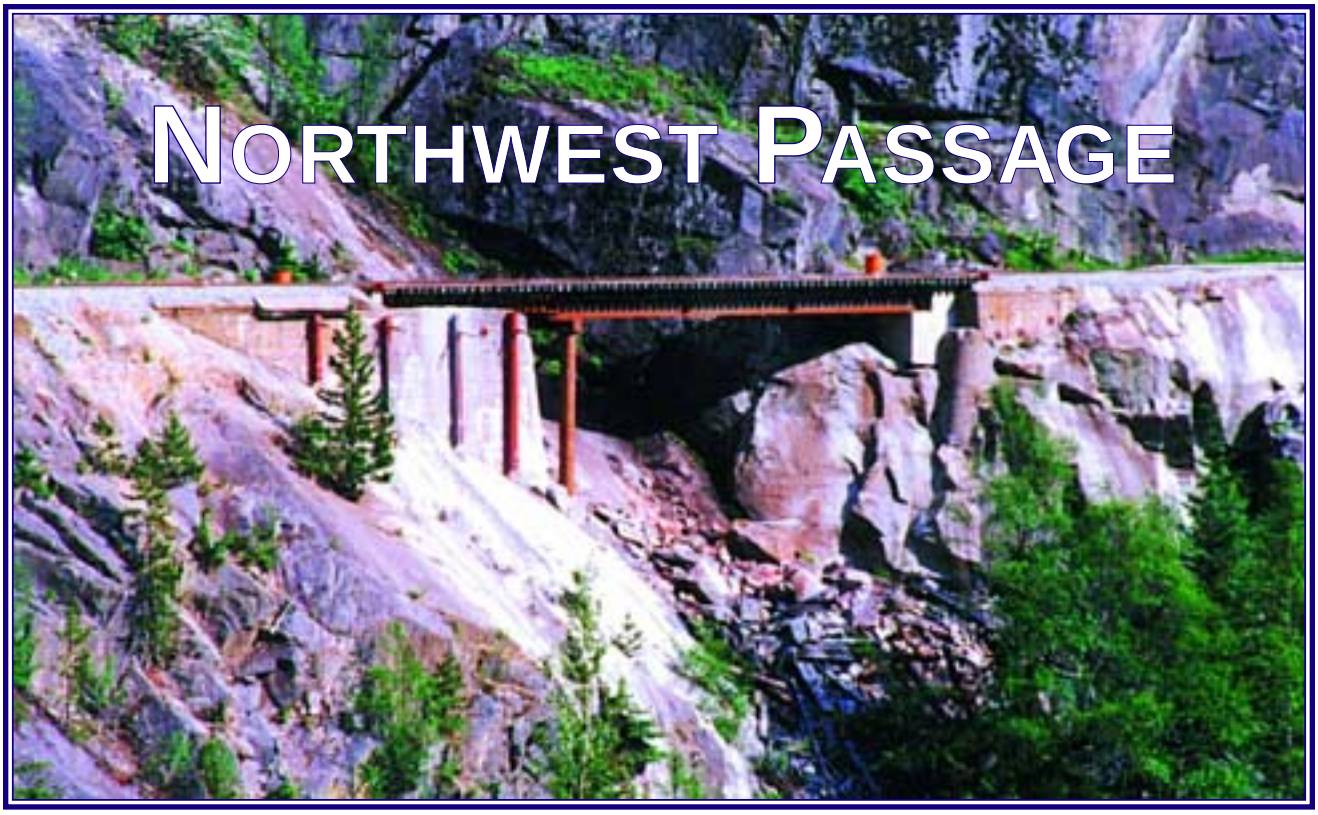
Northwest Passage



The original, seven-span timber trestle Bridge 7B (above) on the White Pass & Yukon Route was destroyed by a rockslide shortly before the start of the tourist season. The two-span steel replacement (top) was designed, fabricated, erected and re-opened to traffic less than three weeks after the rockslide.

A turn-of-the-century mining railroad in Alaska, British Columbia and the Yukon Territory has been successfully converted into an amazing tourist attraction

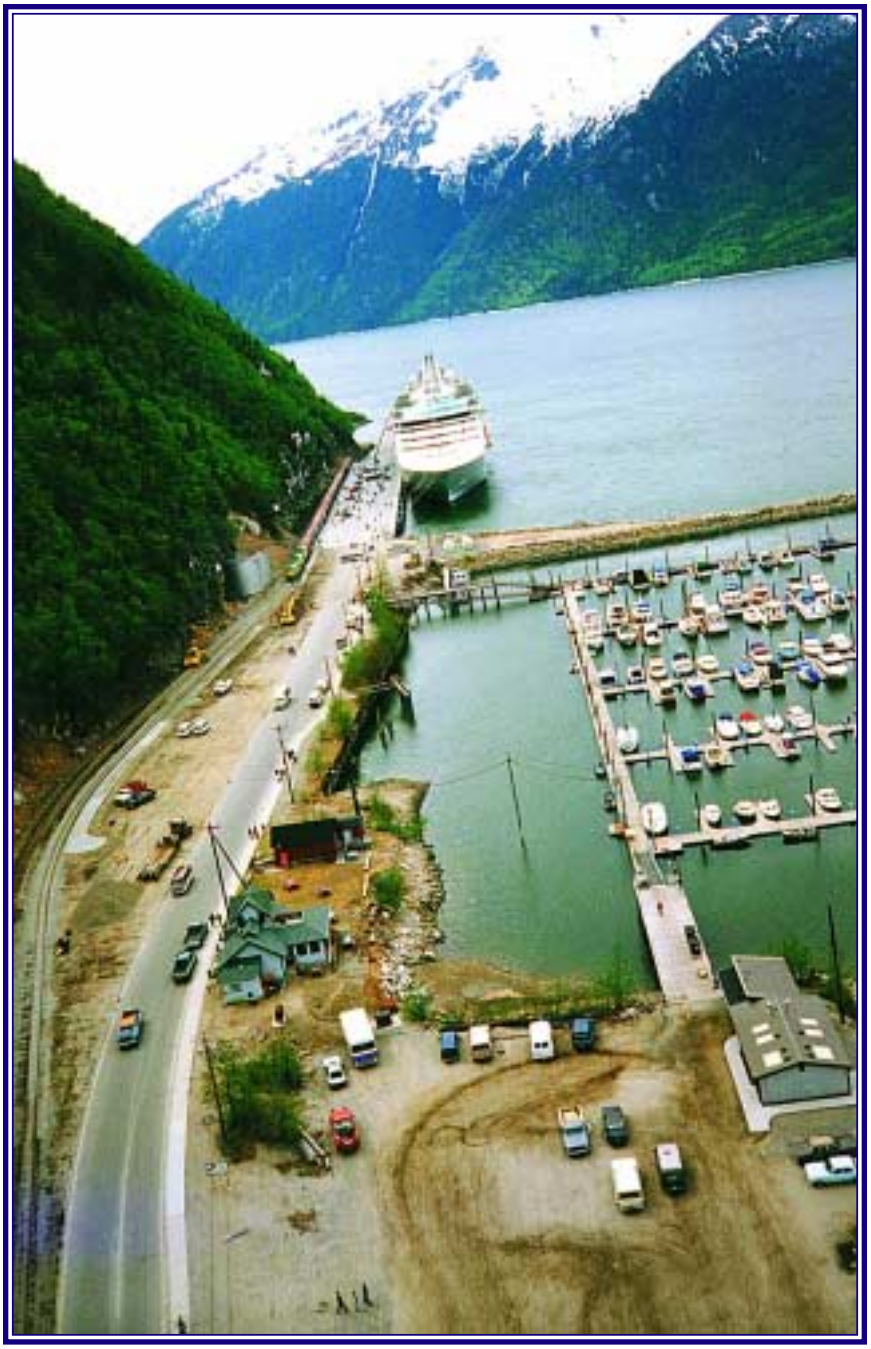
By Todd Nottingham, P.E.

The White Pass & Yukon Route (WPYR) can arguably be called "The Most Scenic Railway of the World". The narrow gauge railway runs from the tidewaters at Skagway, Alaska to White Horse, Yukon Territory, at a total distance of 110 miles. The first 20 miles of the route are in Alaska, winding through steeply sloping, glacier carved mountains with grades as high as 3.5%. Glacier fed streams plummet thousands of feet down these mountains and pass through chasms that are bridged by the railway. Heavy snows, avalanches, rockslides, and cold temperatures are hazards challenged by the railroad.

The White Pass and Yukon Railroad Company was formed at the height of the Gold Rush in 1897, consisting of three separate companies from the areas through which the railroad would operate; Alaska, British Columbia, and the Yukon. Construction of the railroad began in May of 1898 and was completed some 26 months later, culminating with the driving of a golden spike at Carcross, Yukon Territories. A three-foot narrow gauge was used for the line because it was determined that the cost of a standard (4'-8½") railway would be too high.

From inception through 1976, the line transported passengers and freight to and from the Yukon for developments mainly focusing on the mining of natural resources; not only gold, but also copper, lead, zinc and silver. Revenue from these operations was marginal, except for brief periods of increased activity such as World War II. The construction of a state highway parallel to the route, and the less expensive operation of trucking, led to the demise of activities on the line.

The line remained idle for approximately 10 years until the Alaskan tourism boom provided another source of traffic. In 1989, the line was reopened and provided round trips from



The dock in Skagway, AK, is crucial not just for bringing tourists to the railroad, but also for bringing in supplies. After the old timber dock was predominantly destroyed in an underwater mudslide, it was replaced with a dock consisting of steel piles and superstructure topped with a concrete deck.

During a routine annual inspection, it was discovered that the seven-span, tiber trestle bridge 12A (top) had suffered mechanical damage. It was replaced with a new steel girder bridge (middle), which was installed in the fall—after tourist season was over. One of the major challenges faced the project team was the remote location and difficult site conditions. Bridge 15A (above) is located amid steeply sloping terrain. Though the steel bridge has been damaged by rockslides several ttimes, it has always been quickly repaired—and some of its original, 50+-year-old rivited portions remain.

Skagway to the Canadian border, mainly for day-stop tourship passengers. All told, in the first year of tourism 67,000 passengers traveled the line. The railway is growing in popularity, though, and in 1997, over 240,000 passengers took the scenic round trip—and ridership is expected to continue to increase.

WPYR currently provides five berths in Skagway, AK, for tourships that are up to 900' long. Most of these docks are newly built to accommodate the approximately 300 ports of call from various tourships during the summer season. In addition, the railroad operates approximately 40 miles of rail line, which has approximately 15 bridge structures and two tunnels. WPYR is currently working on opening the rest of the line to White Horse.

Bridges and Docks

Since inception, the material of choice for construction of waterfront and railroad bridge structures was timber, which has always been a plentiful resource, and utilizes relatively simple construction methods. Although timber was the choice, several bridges had been constructed of steel, including Bridge 15A and Bridge 9A (see photos). Bridge 9A, located at the scenic Pitchfork Falls, is 30' in length and is constructed of single-span riveted steel. It still bears the plaque noting fabrication in 1905. Bridge 15A has had several spans replaced over the years because of rockslide damage, however there are riveted steel portions of the bridge that are over 50 years old.

Steel structures located in Southeast Alaska are often subject to corrosion from the maritime climate, however Skagway and the Railroad route are subject to a separate microclimate similar to the interior Yukon. This dry microclimate has proven to be beneficial to the uncoated steel used in construction, which has shown only minimal corrosion.

The microclimate also introduced temperatures along the route that have fallen below -50°F. Cold weather fracture was an important item to consider during design of any steel structure in the area.

Recent events, some of which are discussed below, have proven that steel construction has achieved a preferred status in work along the route.

1994 Railroad Dock — In November of 1994, a massive underwater landslide precipitated by a buildup of delta material from the nearby Skagway River, undermined the ocean slope on which the WPYR Railroad Dock was founded. The 1,500-foot timber dock was substantially destroyed from the occurrence. The loss of the dock, which provided two tourship berths signaled economic ruin for WPYR and also for the citizens of Skagway.

WPYR aggressively investigated construction options and selected a dock type that utilized driven steel piles, steel superstructure, and pre-cast concrete deck. Design of the dock and purchase of steel pipe piles as well as steel plate to be used for the superstructure box girders proceeded concurrently. Design was completed and a construction contractor selected by January of 1995. In May of 1995 the first tourship utilized the partially completed dock. Dock construction was complete by September of 1995. Only one tourship berthing was missed.

The 120,000sq.-ft. dock accommodates two tourships 900' in length and supports a tour train along its shoreward 800'. Included in the construction of the dock was approximately 5,000,000 pounds of structural steel and nearly 20,000 linear feet of 30" diameter pipe pile.

The project team included structural engineer Peratrovich, Nottingham & Drage, Inc., Seattle, contractor MKB Constructors, Seattle, and fabricator AISC-member Jessie Engineering Company.

1997 Railroad Bridge 7B — Bridge 7B, a seven-span timber trestle was severely damaged on April 13, 1997 during a rock slide, which was caused by severe freeze-thaw degradation of the overhead granite slopes. Several of the bridges support bents were destroyed and the bridge was shifted several feet down hill during the event. Summer season passenger train operations were scheduled to begin within three weeks of the accident; therefor time was of the essence.

A bridge had previously been designed and the main structural bridge girders had already been fabricated and were currently located in Skagway scheduled for placement during the fall construction season. It was determined that the fastest method to reestablish the bridge crossing was to proceed with construction of the new design, rather than replace the timber bridge in-kind.

The two-span bridges (57' and 28') had concrete abutments and a steel column pier. The superstructure consisted of four wide flange girders fabricated in pairs with open timber tie deck. The total weight of structural steel was 90,000 pounds. Demolition of the remaining timber trestle and construction of the pier and the abutments began immediately. The bridge superstructure was placed with a backhoe and a small hydraulic squirt boom crane, which was the only equipment available that could access the site. Bridge construction was completed by the first week of May with only minimal loss to traffic.

Designer was Peratrovich, Nottingham & Drage Inc., Seattle, contractor was Hamilton Construction and WPYR, Skagway, AK, and fabricator was AISC-member Keiser Steel Fabricators.

1996 Railroad Bridge 26A — Bridge 26A, a thirteen-span timber trestle that crosses a glacier fed river, was supported on hand set timber piles. The timber piles and pile caps were showing degradation and excessive deflection under load. A pile bent replacement program was initiated which involved replacing the existing four-timber pile bent with three driven steel piles spaced to miss the existing timber piles. The steel piles were then capped with a steel wide flange on which the existing timber superstructure is supported. The crews of WPYR performed all work in less than one month.

1997 Railroad Bridge 12A — Bridge 12A a seven span timber trestle was in operation through the summer of 1997, however the annual detailed bridge inspection noted substantial degradation of the timber structure, including some that required immediate temporary repair. Damage to the structure was attributed to age of construction and increased traffic. Because of the success of the recently completed 7B bridge, the decision was made to replace the bridge with steel.

Because of foundation considerations and the need to maintain constructability with available equipment, the length of the main span was required to be 84' with a 20' second span. A double steel box girder with open timber deck was selected for the superstructure. The box girders were fabricated from ½" and 1" plate. The total weight of structural steel was 120,000 pounds.

On-site work began with construction of column footings and column erection in September of 1997. Fabrication of the bridge superstructure was completed and shipped on September 19. On-site bridge construction was completed in mid October. Designer was Peratrovich, Nottingham & Drage Inc., Seattle, contractor was Hamilton Construction and WPYR, Skagway, AK, and fabricator was AISC-member Keiser Steel Fabricators.

While most of the original bridges on the turn-of-the-century rail line were timber, some were built of riveted steel, including Bridge 9A. The 30', single-span bridge still bears a plaque noting fabrication in 1905—and was still in good condition more than 90 years later.

FUTURE

The use of steel construction on the railroad bridges for the White Pass and Yukon Route has been documented from its inception. The success of these bridges is proven in there long and continued life. Recent successful replacement of Bridges 7B and 12A has again provided assurance that steel is the material of choice.

WPYR is currently planning two additional bridge replacements for the fall construction period of 1998.

Todd Nottingham, P.E., is a senior engineer with Peratrovich, Nottingham & Drage Inc., an engineering consulting firm with offices in Anchorage, Juneau, AK, and Seattle.