DEPARTAMENTO DE INGENIERIA

ENGINEERING DEPARTMENT

La designación amplia de "Departamento de Ingeniería" se le da, dentro de la organización, al grupo de actividades que se refieren a la construcción y mantenimiento de la vía, puentes, edificios, muelles, comunicaciones telefónicas y telegráficas. En un ferrocarril como la Northern, estas actividades son primordiales.

Como se ha indicado en la sección del origen histórico del Ferrocarril en este libro, el señor Minor C. Keith y sus hombres vencieron dificultades tremendas para unir las regiones interiores de Costa Rica con los mercados del mundo. Es también cierto que los hombres que han seguido en sus pasos, manteniendo abierto el ferrocarril, han tenido que afrontar días angustiosos.

Aunque la labor de estos últimos no es comparable con la construcción original, no puede negarse que el ferrocarril es uno de los más difíciles en el mundo de mantener en operación. Las lomas escarpadas de las montañas, que son típicas de terreno geológicamente nuevo, no permanecen firmes bajo las lluvias torrenciales que a menudo llegan a 10 ó 15 pulgadas en un día de 24 horas, y que, hasta en una ocasión memorable, llegaron a una precipitación fantástica de 35 pulgadas en 30 horas. En estas condiciones, los riachuelos se convierten en torrentes furiosos mientras que los ríos aumentan su volumen y velocidad violentamente, arrastrando árboles, piedras y despojos en su trayecto con tanta impetuosidad que el estruendo es perceptible por más de una milla. Las líneas, la trocha y los puentes son barridos por la furiosa creciente; enormes avalanchas de lodo, rocas y árboles se desprenden estrepitosamente de las faldas de las montañas, barriendo o enterrando cualquier construcción que se encuentre en su camino.

Cuando las aguas vuelven a su normalidad, por todos lados se ve desolación. Puentes gigantes de acero, que se consideraban inconmovibles quedan como montones de acero retorcido a centenares de yardas de su lugar original; los rieles quedan como clavados verticalmente y retorcidos en formas caprichosas o han desaparecido totalmente; las riberas de los ríos se han erosionado violentamente, y en algunos lugares las aguas, algo calmadas, azotan los peñascos verticales donde antes estuvo un terraplén de ferrocarril, completo con sus vías y sobre las cuales los trenes habían pasado; la línea en algunos cortes y en cortes a las orillas de las peñas queda cubierta, a gran profundidad, por masas de fango, piedras, lodo y árboles, que con las barrialosas laderas, todavía convertidas en masa plástica, corren hacia y a través de la vía; pequeños puentes han desaparecido, dejando las líneas colgando en el aire, como un puente de suspensión; las líneas telefónicas y telegráficas quedan en el suelo y en muchos lugares han sido arrastradas y muy probablemente la lluvia continúa cayendo de las nubes bajas y pesadas.

Bajo estas condiciones, los hombres de mantenimiento salen para hacerse cargo de lo, aparentemente, imposible. A pesar del lodo y la lluvia y la improbabilidad del buen éxito, se emprende el trabajo. Primeramente, las cuadrillas de vía aisladas tratan de abrirse contacto, una con otra, limpiando pequeños derrumbes, temporalmente bloqueando líneas lavadas, abriendo trillos por matorrales alrededor de lavados y derrumbes que de otra manera no pueden ser cruzadas y, en general, estableciendo, de nuevo, comunicaciones entre sí y con los centros de operaciones, para poder así reorganizar el envío de materiales y provisiones.

Mientras tanto, los ingenieros supervisores han comenzado a estimar los daños y a levantar los planes para la rehabilitación de la línea. En carros de vía en donde todavía hay vía, o si no a pie; cruzando ríos todavía crecidos donde los puentes han sido destruídos; subiendo por encima y alrededor de derrumbes, abriendo su camino, para dar entusiasmo, más que instrucciones, hasta que han recorrido toda la línea.

The broad designation of "Engineering Department" is given to the group of activities having to do with construction and maintenance of track, bridges, buildings, wharves, telephone and telegraph communications. On a railway, such as the Northern, these responsibilities are paramount.

As recorded in the historical background section of this book, Mr. Minor C. Keith, and his men, overcame almost unsurmountable difficulties to link the heartland of Costa Rica to the markets of the world. It is also true that the men who have followed in his footsteps, keeping the railroad open, have faced some trying days.

Although their task cannot be compared to the original construction, the railway is recognized as one of the most difficult in the world to maintain. The steep mountain slopes, typical of the geologically young terrain, will not stand up under the torrential rains which often reach 10 or 15 inches in a 24-hour day, and one memorable occasion reached the fantastic precipitation of 35 inches in 30 hours. Under these conditions, small streams become furious torrents while the larger streams are raging crescendos of water, tossing trees, boulders and other debris about so violently that the noise can be heard for more than a mile. Tracks, road bed and bridges are swept up in the angry flood, huge avalanches of mud, rock and trees crash off the mountain slopes sweeping away, or burying, any structure within its path.

Once the waters finally subside desolation is seen everywhere. Giant steel bridges, once thought to be unmovable, are observed to be twisted masses of steel hundreds of yards from their original locations; tracks are upended and swept into fantastic patterns, or have disappeared altogether; river banks have eroded violently and, in places, the subsiding waters are lashing against vertical cliffs where once had been a railroad embankment, complete with tracks, over which trains had moved; tracks in cuttings and side hill cuts are covered to great depths with masses of slush, boulders, mud and trees with, perhaps, the soaked hillsides still a plastic mass flowing into and across the tracks; small bridges have disappeared leaving the track hanging in the air like a suspension bridge; telephone and telegraph lines are down and, in many places, carried away; and, most probably, the rain continues to fall from low hanging, sodden, clouds.

Under these conditions, maintenance men go forth to undertake the apparently impossible. In spite of mud and rain, and the improbability of success, the job is undertaken. At first, the isolated track gangs try to work their way to one another by hand-cleaning small slides, temporarily blocking up washed out tracks, cutting jungle paths around washouts and slides that cannot be otherwise crossed and, in general, re-establishing communications with one another, and with the centers of operation, so that the flow of materials and supplies can be reorganized.

Meanwhile supervising engineers have started out to assess the damages and make the master plans for the rehabilitation of the line. On track cars where there is a track to run on, otherwise on foot and crossing rivers, still at reduced flood stage, where bridges were washed away; climbing over, and around, slides they make their way giving encouragement, more so than instruction, until they have traversed the whole line.

Gradually the situation is clarified. First attention is given to telephone communications, and then to establishing motor car traffic between the points of greatest damage. Heavier equipment gradually moves forward, building temporary wood pile trestles to replace washed out bridges; clearing slides with bulldozzer, clam shell or steam shovel; filling up washed out track; reconstructing track that has disappeared. Soon, longer and longer

La situación se va aclarando gradualmente. Atención principal se da a las comunicaciones telefónicas, y después al establecimiento de tráfico de carros motores entre los puntos de mayores daños. El equipo pesado gradualmente va entrando, construyendo viaductos de pilotes de madera de uso temporal para sustituir los puentes que han sido lavados; limpiando derrumbes con tractores, grúas, dragas, o palas de vapor; rellenando la trocha lavada; reconstruyendo la línea que ha desaparecido. Pronto más y más trechos de línea quedan en condiciones para el tránsito de locomotoras pesadas a velocidad reducida. El tráfico comercial se abre tan pronto como la trocha esté restaurada y, con el tiempo, se transporta la acumulación de carga y pasajeros atrasados. La vía está expedita.

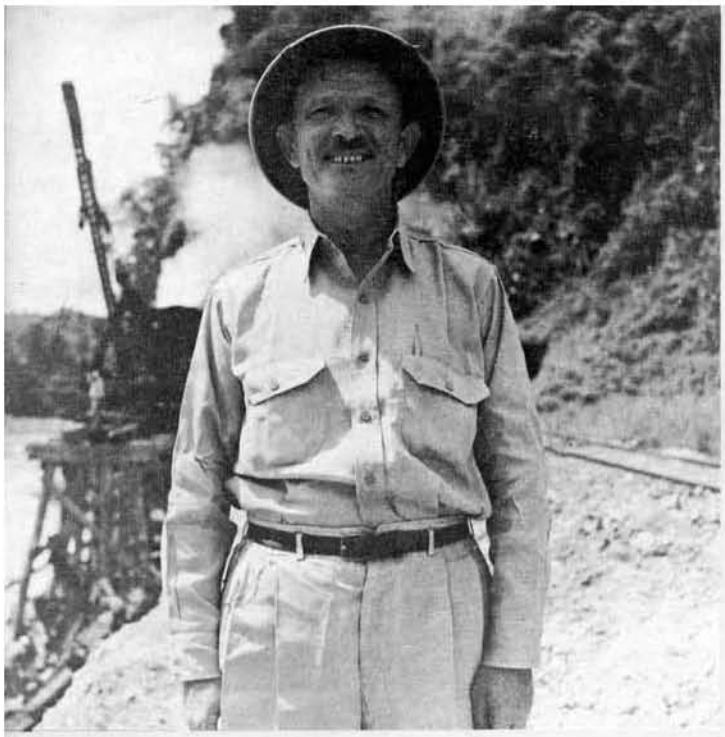
En un párrafo se relata todo esto, pero nada dice de las horas largas, el peligro y las angustias que el trabajo exigió. Nada nos cuenta de levantarse antes del amanecer, ponerse ropa mojada para seguir trabajando otro día y el regreso al campamento después de anochecer para caer en un sueño soporífico. Tampoco nos relata nada de la fuerza vital y de la resolución firme que son necesarias para sostenerse durante siete días de la semana, durante semanas y aún meses. No nos revela la llamarada de terror que paraliza el alma del hombre cuando, al cruzar un río crecido, se resbala y es llevado aguas abajo, sólo con la esperanza de que será barrido a la orilla y no llevado aguas abajo para convertirse en alimento de lagartos. No cuenta nada del peso de responsabilidad que un ingeniero debe asumir cuando lleva sus trabajadores bajo un peñasco inestable, que él siente no es seguro, para limpiar un derrumbe con el fin de restablecer el tráfico. Nada dice de la depresión que pesa sobre los hombres cuando, después de casi terminado un trabajo, el río sube otra vez y se lleva su esfuerzo, o un nuevo derrumbe cae y llena lo que ha sido limpiado mediante horas o aun días de trabajo abrumador.

No obstante, hay compensaciones: los hombres que hacen frente a estas tareas son movidos por el mismo espíritu que una vez inspiró al señor Minor C. Keith a expresar que "él podía construir un ferrocarril en cualquier lugar que un río pudiera correr". La satisfacción que viene al vencer los desastres naturales y cumplir con la responsabilidad de poner los trenes en marcha llega a su punto álgido cuando el primer tren pasa. Es prácticamente una experiencia religiosa el contemplar los rostros de los ingenieros y trabajadores, todos igualmente llenos de barro, mojados, y con las hondas líneas de agotamiento en sus semblantes, cuando se hacen a un lado de la línea para saludar el paso del primer tren.

stretches of line are in condition for heavy locomotives at reduced speed. Commercial traffic is opened as fast as track is restored and, eventually, through traffic is moving the back log of accumulated freight and passengers. The line is open.

One paragraph tells the story, but it does not tell of the long hours, danger and heartbreak that went into the job. It does not tell of the rising before daylight; putting on wet clothes to face another day; and the return to camp after nightfall to collapse with fatigue into a drugged sleep. It does not tell of the stamina and dogged purpose required to keep this up, seven days a week, for weeks or even months. It does not tell of the flash of terror that sears a man's soul when, in crossing a swollen river, he loses his footing and is swept downstream, only hoping that he will be swept up on the bank and not carried downstream to become alligator's food. It does not tell of the weight of responsibility that an engineer must assume when he leads men in under an overhanging, unstable, rock cliff, that he feels is not safe, to clean a slide so that traffic may be restored. It does not tell of the depression that weighs on men when, having a job almost done, the river rises again and carries his work away or a new slide comes down and fills up the opening that has been made by hours, or even days, of back-breaking toil.

But there are compensations: men who face these jobs are actuated by the same spirit that once moved Mr. Minor C. Keith to remark that "he could build a railway anywhere a river could flow". The satisfaction that comes from overcoming the natural disasters, and fulfilling one's responsibility to move the trains, is at a climax when the first train goes through. It is practically a religious experience to watch the countenances of engineers and labourers, all equally muddy, wet, and with the deep lines of exhaustion in their faces, as they step to one side of the track to signal the first train by.



Don Alejandro Karpinski, Superintendente del Departamento de Ingeniería, quien es responsable de todas las actividades de este Departamento.

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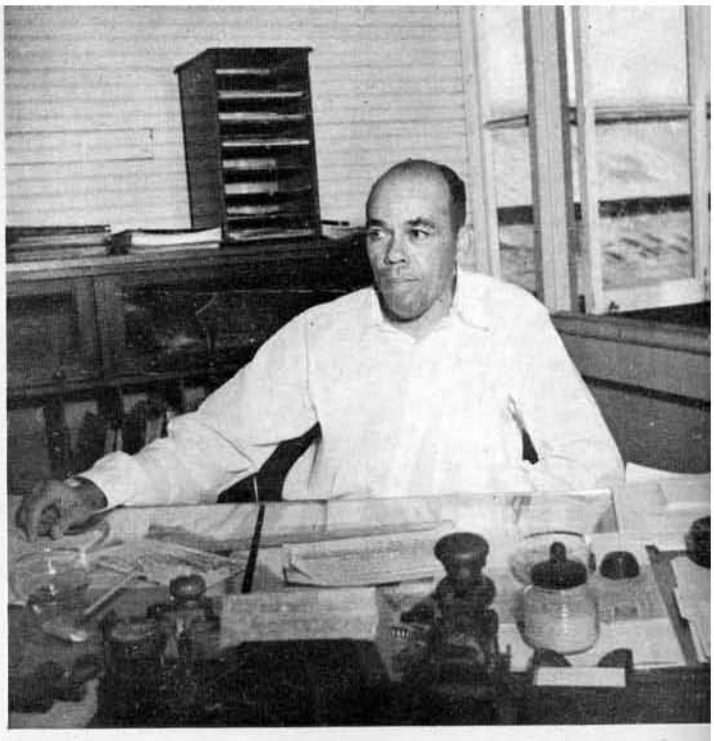
Mr. Alejandro Karpinski, Superintendent of the Engineering Department, who has overall responsibility for all activities of the Department.



El Sr. Leopoldo Greenwood, Encargado de Asuntos de Oficina de los Departamentos de Ingeniería y Mecánica.

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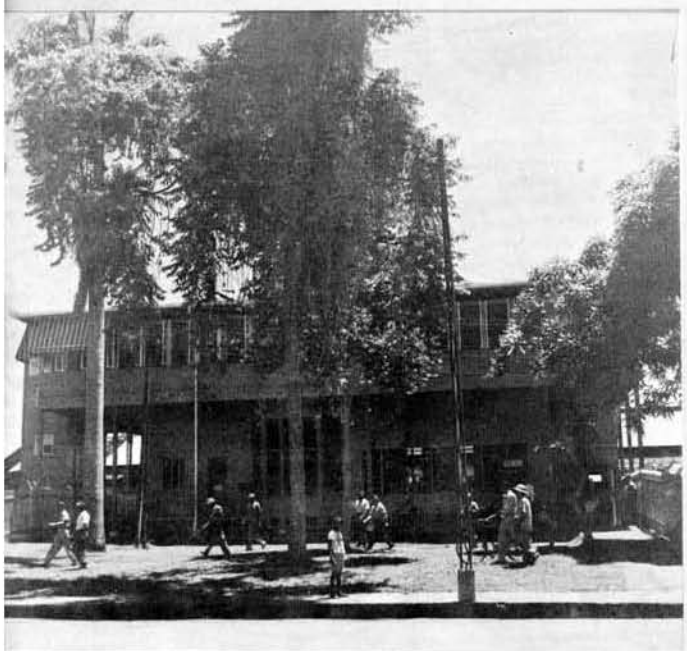
Mr. Leopold Greenwood, Executive Chief Clerk of Engineering and Mechanical Departments. Mr. Greenwood is responsible for all office affairs.



En este edificio se encuentran las oficinas de los Departamentos de Ingeniería y Mecánica.

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Building housing offices of Engineering and Mechanical Departments.

Personal de las oficinas de los Departamentos de Ingeniería y Mecánica.

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Office personnel of the Engineering and Mechanical Departments.

Sr. Gonzalo Castillo: Supervisor de la División del Oeste
(La Junta hasta Alajuela).

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Gonzalo Castillo: Supervisor West Division
(La Junta to Alajuela).

Sr. Stanley McDonald: Supervisor de la División del Este
(Limón hasta La Junta y todos los ramales).

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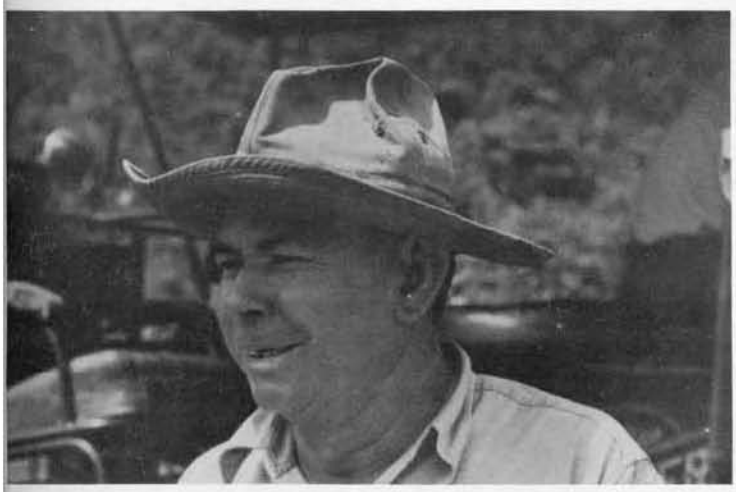
Stanley McDonald: Supervisor East Division
(Limón to La Junta and all branches).



Sr. Pánfilo Solano: Capataz de Puentes.

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Pánfilo Solano: Bridge Foreman.

Sr. Alejandro Grant: Inspector de Puentes y Comprador
de Traviesas y Maderas.

⊙

Alexander Grant: Bridge Inspector and Timber Buyer.

Sr. Moisés Pereira: Capataz de las Cuadrillas
de Construcciones de Acero.

⊙

Moisés Pereira: Steel Erection Gang Foreman.

Sr. Miguel Vargas: Capataz de la Cuadrilla de Albañiles.

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Miguel Vargas: Masonry Gang Foreman.

En tiempos normales once cuadrillas en varios sectores, son empleadas en el mantenimiento rutinario de la vía. Esta es la vista familiar al público, una cuadrilla alineando y nivelando la vía cerca de Rincón. Todas las cuadrillas disponen de carros-motor "Casey-Jones". En una emergencia, todas las cuadrillas pueden ser concentradas en pocas horas. Antes de contar con esos motores se necesitaban 33 cuadrillas para mantenimiento rutinario y, en una emergencia, no podían ser concentradas excepto corriendo trenes especiales con gran atraso y costo.

⊙

During normal times eleven section gangs are engaged in routine track maintenance. This is the sight familiar to the public, a gang lining and surfacing track near Rincón. All gangs are equipped with heavy duty "Casey-Jones" motor-cars. In an emergency all gangs can be concentrated within a few hours. Before motorization, 33 gangs were required for routine maintenance and, in emergencies, they could not be concentrated except by running special trains at great delay and cost.

Una cuadrilla con su carro-motor y carros de remolque para herramientas. Los carros-motor corren con órdenes de tren exactamente como los trenes. Al llegar al lugar de su trabajo se coloca el carro fuera de la vía utilizando para esto una tornamesa portátil. Un teléfono mantiene al operador en contacto con el despachador de trenes.

A section gang with it's motor-car and trailers for tools. Motor-cars run on train orders exactly the same as trains. Arriving at the location of the day's work, the car will be set off track by use of a portable turntable. A portable telephone keeps the operator in touch with the train dispatcher.

El quemador de hierbas, de vapor recalentado, se usa para despejar la via de zacate y hierbas. Para limpiar la trocha se usan machetes. Este trabajo costó, durante el año fiscal 1952-1953, $ 13,841.31 (₡ 78,480.20).

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Super-heated steam weed burner keeps track clear of grass. Right-of-way is cleaned with "machetes". During the fiscal year 1952-1953 this work cost $ 13,841.31 (₡ 78,480.20).

Lubricador automático para rieles. Cada vez que pasa una rueda por este punto, hace funcionar una bomba que a su vez expele unas gotas de aceite crudo por unos orificios en la orilla del riel. El lubricante es recogido por las ruedas al pasar y de esta manera lubrican los rieles en las curvas. Este lubricador fué diseñado y construido por la Northern.

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Automatic flange lubricator. Each passing wheel activates a pump that forces a globule of fuel oil out of holes in ball of rail. Oil is picked up by wheels to lubricate rail on curves. This lubricator was designed and built by the Northern

Encubados de concreto fabricados por la Northern, usados para refuerzo de terraplenes.

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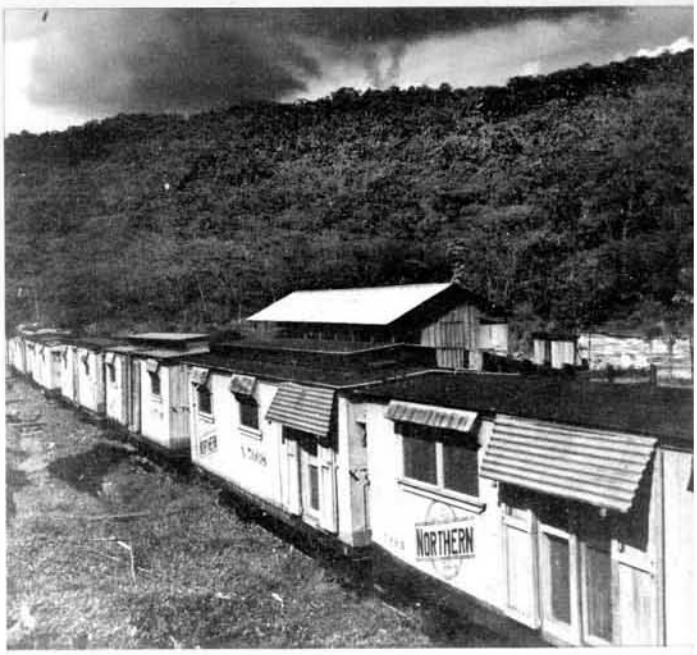
Concrete cribbing, manufactured by the Northern, is used to stabilize embankments.



En estos carros habitan cuadrillas extras de obreros que hacen trabajos especiales demasiado grandes para las cuadrillas regulares. Estos carros incluyen un carro-cocina y un carro-comedor comunes y pueden movilizarse en cualquier momento.

⊙

The extra track gang is assigned to special jobs too big to be handled by regular section gangs. The gang lives in these cars with central kitchen car and dining car, ready to move any time.

Esta roca, en la superficie de un corte lateral, puede causar molestias tales como las que se muestran en las siguientes fotografías. Sería imprudente excavar a su alrededor pues se podría originar un desprendimiento de tierra.

⊙

A boulder in side of cut which might cause trouble, such as recorded in following pictures. It would be imprudent to remove this boulder by excavation, as to dig into the cut might start a large landslide.

Rocas, tales como la que muestra la fotografía anterior, algunas veces caen a la vía, causando daños serios al riel, como vemos aquí. Naturalmente antes de poder restablecer el tráfico normal es necesario quitar esta roca y reemplazar el riel.

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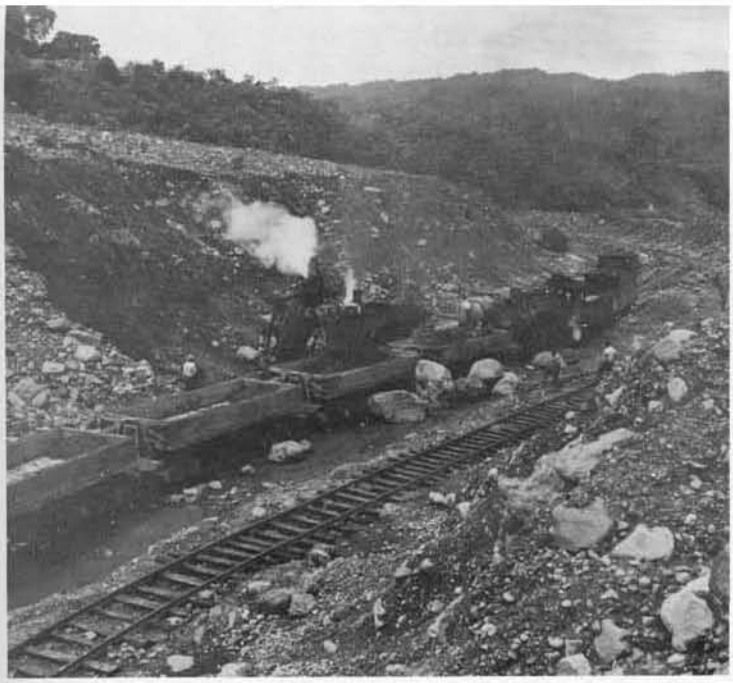
Such boulders, as in previous photograph, sometimes fall with damage to track, such as this badly damaged rail. Of course, boulder must be removed and rail changed before traffic can move normally.

Algunas veces la vía se puede despejar tan fácilmente como se ve en esta fotografía. El riel está dañado y será reemplazado pero mientras tanto, un tren puede pasar por este punto a una velocidad baja indicada. No todo el mantenimiento de la vía es tan espectacular ni de esta naturaleza. Sin embargo, es necesaria la vigilancia constante.

⊙

Sometimes track can be cleared as simply as this. The rail is damaged and will be replaced, but inasmuch as it is not broken, trains can pass under speed restriction. Not all maintenance of way difficulties are of such spectacular size or nature. Constant vigilance must be maintained and personnel permanently available to keep track clear after a small interruption such as shown here.



Una pala de vapor carga carros de volteo para hacer un corte de 40 pies a través de un derrumbe.

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Steam shovel loads air dump cars to make a 40 ft. cut through a slide.

Una draga de arrastre con motor Diesel en su trabajo.

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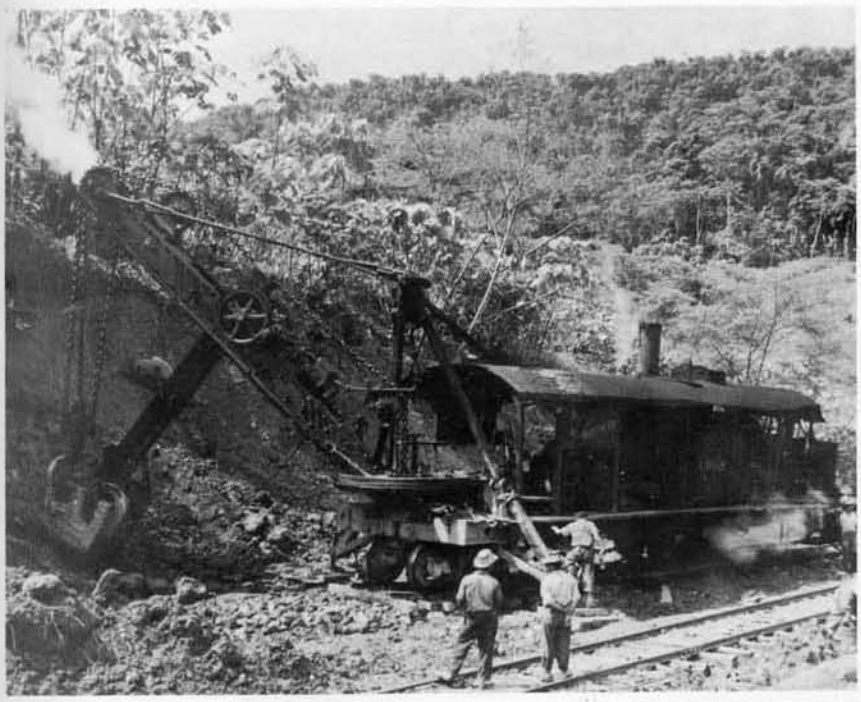
Diesel powered dragline at work.



Una pala de vapor empezando el trabajo de ensanchar un corte.

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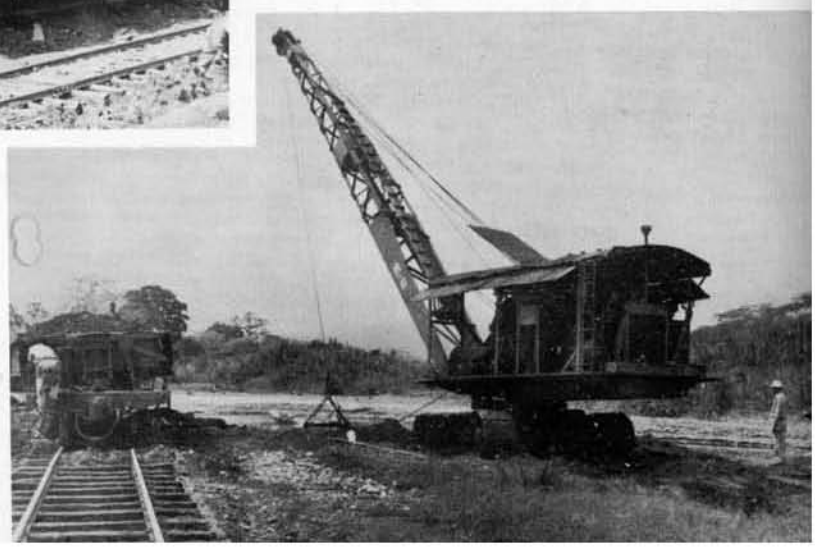
Steam shovel starting to widen a cut.



Una draga de arrastre cargando grava fluvial (balastre). La excavación se hace en agua corriente de manera que el lodo y los sedimentos sean lavados, quedando la arena y grava limpias.

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Dragline loading river gravel. Digging is done in running water so that mud and silt are washed away leaving clean sand and gravel.

LA JUNTA

Una historia breve del Puente de La Junta:

Durante toda la historia del Ferrocarril el cruce del río Reventazón en La Junta, ha sido uno de los problemas de mayor preocupación. Básicamente, la dificultad consiste en que el lecho del río se compone de pedrones enormes y redondos que hacen muy difícil excavar suficientemente hondo para colocar cimientos adecuados; sin embargo, esos pedrones, muchos de los cuales tienen de ocho a diez pies de diámetro, son arrastrados por las tremendas torrentadas en períodos de inundaciones grandes.

El puente original fué totalmente destruído por inundación en Diciembre de 1908, y fué repuesto por uno de armadura de acero de 400 pies, construído en tierra y movido a su posición. Esta estructura pesa 700 toneladas, y la obra era tan singular que mereció un artículo en el "Engineering News" del 7 de diciembre de 1916. (Vea el grabado).

De 1909 hasta 1940 toda el agua del Reventazón pasó por debajo de esta estructura de 400 pies, pero cambios en el canal principal del río, aguas arriba, causaron una erosión seria en la ribera oeste, con el resultado de que los rellenos de acceso fueron lavados, y esto hizo necesaria la construcción en 1940 de un tramo adicional de 160 pies.

Con perversidad tradicional el caudal principal del río prácticamente abandonó su curso original viejo, debajo del puente de 400 pies e hizo más profundo el curso en el extremo oeste del nuevo tramo de 160 pies al punto de que el cimiento oeste fué arrastrado en Diciembre de 1943. Este tramo fué recobrado y eregido de nuevo sobre un cimiento todavía más hondo, pero la mayor inundación conocida de Diciembre de 1949 arrasó tanto el puente como el cimiento llevando el tramo unos 2000 pies aguas abajo. Al mismo tiempo continuó lavándose en la orilla oeste del río, ensanchando la anchura de la abertura hasta 250 pies. Esto se solucionó mediante el usual puente de pilotes y armadura de madera, de uso temporal, y poco después fué repuesto por un tramo de acero de 250 pies que ahora está en uso.

En un esfuerzo de evitar más lavaderos en la ribera oeste y de que se profundice el agua a lo largo del nuevo cimiento, se ha construído un gran deflector de concreto a poca distancia aguas arriba para desviar la corriente de agua hacia el tramo principal de 400 pies.

Es de suponer que con la abertura actual de 650 pies, protegida por el nuevo deflector, la estructura está ahora segura, pero la amarga experiencia ha demostrado que pocos, o tal vez ninguno, de los cimientos y estructuras sobre el río Reventazón pueden garantizarse como estables.

Brief History of La Junta Bridge:

During the entire history of the Railway the crossing of the Reventazón river at La Junta has been one of the most troublesome. Basically, the trouble lies in the fact that the river bed consists of large round boulders which make it extremely difficult to excavate sufficiently deep for adequate foundations; yet the boulders, many of them from eight to ten feet diameter, are moved by the rushing torrent during periods of extreme flood.

The original bridge was completely destroyed by flood in December 1908, and was replaced by a 400-ft. truss, erected on shore and launched into position. This structure weighs 700 tons and the job was so unique that it was written up in the "Engineering News" of December 7, 1916. (See cut).

From 1909 until 1940 all the water of the Reventazón passed under this 400-ft. span; but then changes in the main channel of the river, upstream, caused serious erosion on the west bank, resulting in the washing out of the approach fills which made necessary the construction of an additional 160-ft. span.

With traditional perversity the main stream practically abandoned its old course under the 400 ft. span and deepened the channel under the west end of the new 160-ft. span to a point where the west foundation was washed out in December 1943. This span was salvaged and re-erected on a still deeper foundation, but the record flood of December 1949, carried away both bridge and foundation, sweeping the span about 2000 ft. downstream. At the same time the west bank of the river was still further eroded, enlarging the width of the opening to 250 feet. This was bridged with the usual temporary wooden trestle bridge, which was replaced shortly afterwards with a 250-ft. steel truss span, now in use.

In an attempt to prevent further eroding of the west bank, and any deepening of the water alongside the new foundation, a large concrete deflector has been constructed a short distance upstream to divert the current of water towards the main 400-ft. span.

It is believed that with the present total of 650 feet of opening, protected by the new deflector, the structure is now secure but bitter experience has taught that few, if any, foundations and structures on the Reventazón river can be guaranteed to last.

Lamentablemente no tenemos a mano fotografía alguna del puente original sobre el río Reventazón para incluirlo en este libro. El artículo, reproducido aquí, de la "Engineering News" del 7 de diciembre de 1916 hace una descripción de las dificultades tremendas que se presentaron en la construcción del primer puente de reposición y las medidas extraordinarias desarrolladas para vencerlas. Muchos, si no casi todos, de los problemas de ingeniería en la Northern Railway son únicos y es necesario solucionarlos con la mayor ingeniosidad.

Unfortunately, no pictures of the original bridge which spanned the River Reventazón at La Junta are available for inclusion in this book. The article, here reproduced, from the "Engineering News" of December 7, 1916, describes the tremendous difficulties attending the construction of the first replacement bridge and the unique arrangements involved to overcome them. Many, if not most, of the engineering problems of the Northern Railway are unique, and the greatest ingenuity is required to solve them.

Raising a Bridge by Levers When Jacks Failed

By W. T. Penney*

The ingenious plan adopted for raising the 640-ft. central span of the Quebec bridge from the scows to the final position reminds me of an emergency caused by the failure of the jacks used in jacking up a 400-ft. span weighing 700 tons.

In December, 1908, after unusually heavy rains, several bridges on the Costa Rica Ry. were washed out. The president of the road, Minor C. Keith (now president of the International Railways of Central America, which operates nearly all the lines in Central America), employed A. W. Buel, Consulting Engineer, of New York, to inspect the washed-out structures and make a report on their reconstruction. One of them crossed the Reventazon, one of the principal rivers in Costa Rica. As this river has a very rapid fall and often becomes a veritable torrent, it was considered unsafe to construct falsework for the erection of the new bridge. It was decided to design a 400-ft. span to be erected on shore and launched into position over a temporary cylinder pier erected in midstream. The span was designed to provide for the unusual strains occasioned by the manner of launching into position, as well as the strains due to the cantilever projection of half the span during launching. The end floor-beams were designed unusually heavy, as all the jacking in raising and lowering the span was to be done under them.

The span weighed 700 tons when erected and ready for launching. The permanent abutments consisted each of a pair of 12-ft. cylinders suitably braced together and filled with concrete. The temporary center pier was a pair of 10-ft. cylinders, braced transversely and guyed with steel cables to the launching abutments. In order to provide for the heavy bending moments in launching, double lines of plate-girder stringers 4 ft. deep were bolted to the bottom flanges of the lower chords, from end to end of the span, to fit roller tracks. The stringers used for this purpose were those permanently belonging to the span and 20 from another span still to be erected.

The available space for the erection of the span on the shore was limited. For this reason, when the erection—beginning at the outer end of the span, which rested on an instant set of rollers—had passed the central panel of the span, the erection gantry remained stationary and the bridge was launched panel by panel from under it. The last-erected entire panel rested on the rear pair of rollers and the outer end on those placed on the first abutment. After the timber blocks were removed and the span swung, it had already been launched about a third of the way.

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Each truss was pulled forward by two huff tackles, operated by an estimated initial force of between 65,000 and 75,000 lb. Each tackle consisted of a pair of 20-in. triple blocks rove with 5/8-in. steel cable lines with a huff composed of a pair of 14-in. blocks rove with a 1 1/4-in. manila line. The latter led to the winch heads of the erecting engines on the traveler; this made a steady, uniform haul.

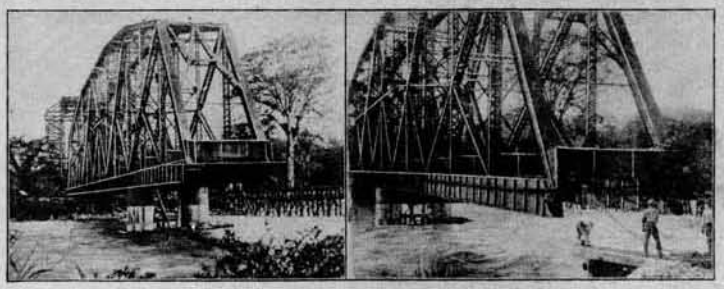
The steel-cable tackles were secured at one end to loops of wire cable previously embedded in the concrete of the cylinder abutments for this purpose and for use in raising the traveler. The other end of the tackles was chain-hooked to the lower edge of the track stringers and moved back as the span advanced; thus all the work of overhauling the tackles was on the shore. A skidding track of 12x12-in. timbers was placed horizontally in the plane of each truss, between the launching abutments and the temporary rear roller pier. A transverse rail was bolted across the lower flanges of the rolling stringers, just before the latter left the rear roller temporary pier, so that it engaged the longitudinal rails and prevented any possible drop. A precautionary 4-ton counterweight of rails was placed on the rear end of the span, and it passed smoothly from the rollers to the skid rails. The writer suggested that a temporary pilot projection, about 10 ft. long, be built and bolted to the front end of the rolling stringers, so that when the center of gravity of the span approached the launching abutment the ends of the pilot engaged the fixed rollers on the temporary cylinder pier.

As there was a downgrade between the initial and final positions of the bridge, a heavy preventer tackle was provided to control the launching, but this was found unnecessary, as there was no tendency developed to move, except as the bridge was hauled by the huff tackles. The last 100 ft. of launching was assisted by a hoisting engine placed on the opposite side of the river beyond the abutment.

There being no anchorages available from which to guy the span transversely during launching, and some precaution against wind pressure being necessary, I moved the heavy erecting traveler to the best position for the purpose and blocked between the roller stringers and the traveler sills, spiking iron plates on the blocking and leaving a space of 1 in. With this arrangement, before the span could get out of line the traveler would have to move sidewise. When the launching was completed, I examined these plates and found them deeply marked from being in contact with the span, showing that the span had been forced back to position by its resistance.

When the span was launched, the end was jacked up to remove the roller bearings on the temporary center pier. It was supported on 7 ft. of blocking above the top of the cylinder abutment. The superintendent decided to raise the masonry 3 ft., to effect a reduction of the grade; even with this modification the bridge had to be lowered 3 1/2 ft. The work was commenced with a number of 50-ton Norton jacks. Every precaution was taken to load these jacks uniformly, but three of them failed completely, and the remaining jacks were not sufficient to raise the load.

FIG. 2. LEVER RIG RAISING THE END OF REVENTAZON RIVER BRIDGE



FIGS. 1 AND 2. LAUNCHING A 400-FT. SPAN OVER A TORRENTIAL STREAM

To avoid delay an improvised method of lowering the bridge was devised by the writer and by the superintendent of bridges, R. Schutt, and was used successfully.

Four end posts of another bridge on the line, which happened to be available, were borrowed and used as levers. As these posts were 50 ft. long and weighed 8 tons each, they made serviceable levers. The short ends of the levers engaged the lower side of the end floor-beams. These beams had been reinforced for jacking, making them amply strong for the lever strains. In order that these posts could be easily and quickly handled and in view of the short ends requiring little movement, they were supported by a steamboat ratchet, one end hooked to a timber placed across the span, the other ends to the levers. As the opposite ends of the levers had to be raised about 18 ft., they were operated by tackles from a bent placed for this purpose. This bent, built of 12x12 timbers, had a leg on each side of all the levers, thus virtually forming a slot for them to work in and preventing any side kick when carrying the load. As a further precaution against this danger the end of the span was cross-guyed with chains and steamboat ratchets. The heels for the levers were of sawn oak 6x12 in. by 12 ft. cross-piled, with fulcrums consisting of car axles laid on steel plates placed on top of the cribs.

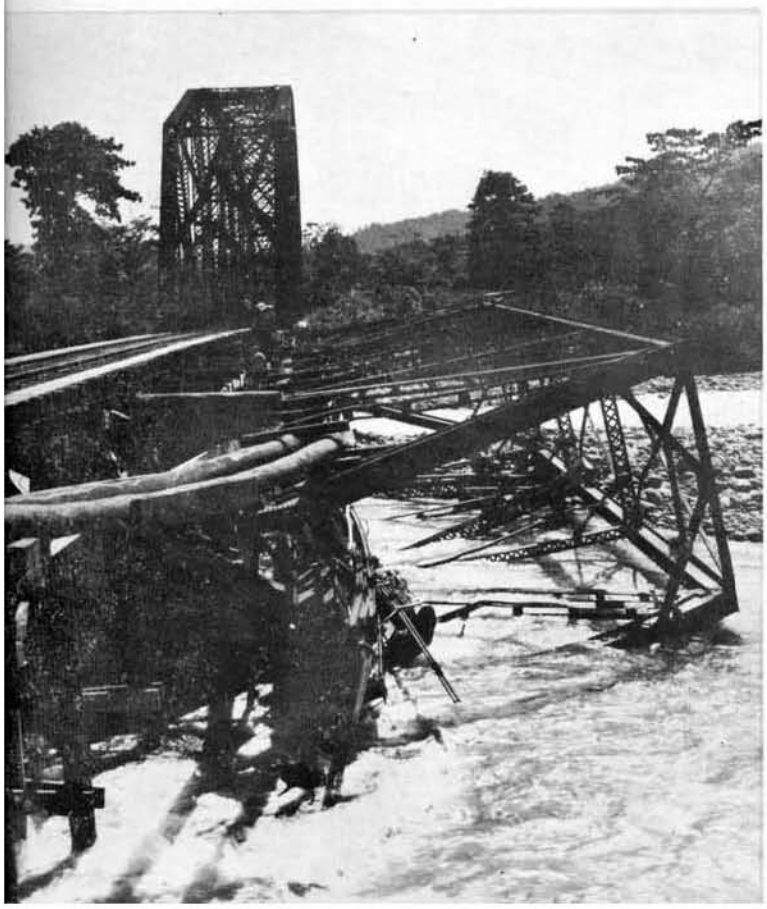
The fall lines of the lever tackles ran to the winch heads of a hoisting engine. The ends of the levers were 18 ft. above level when finally placed. When all was ready, the levers were lowered and their supporting tackles overhauled. It was supposed that the weight of these immense levers would raise the span, but it never moved. There being a pile of boxes of rivets near-by, one box was placed on the end of each lever—it took eight boxes on each lever to raise the span, or 12 boxes in all; they must have weighed some 200 lb. each.

When the span did rise, it came up as easily as a pair of scales, the levers coming down on blocking already prepared for them. When the cribbing under the spans, consisting of rail ends 4 ft. long—afterward incased with concrete—was properly adjusted, the boxes of rivets were removed, one at a time. This operation was repeated for each 6 in. height of blocking to be removed. A total of 3 1/2 ft. lowering was accomplished in 20 hr. The launching of the span occupied 10 hr., one-half of which time was consumed in overhauling and adjusting the tackles.

The scheme of erection was that of A. W. Buel in consultation with Minor C. Keith. Mr. Buel also designed the erecting traveler. The bridge was designed and fabricated by the Baltimore Bridge Co., H. B. Bush, Vice-President and Chief Engineer, H. W. Shaw and George F. Dilly, Assistant Engineers. The erection was done under contract by the writer. R. Schutt was Superintendent of Bridges and Buildings for the railway.

Esta es la única fotografía existente de un tramo de 160 pies construído en 1940, después que el río había desgastado la orilla (ribera) oeste abriendo un cauce nuevo el cual hizo necesaria la construcción de una apertura adicional.

This is the only photo of a shortlived 160 foot span erected in 1940 after the river had eroded the west bank, opened a new channel (uppermost in photo) and made necessary the construction of an additional opening.



En Diciembre 1943 al hacerse más hondo el cauce socavó los cimientos del tramo en la ribera oeste del río, haciendo que el puente y los cimientos se volcaran río arriba. La fotografía muestra la armadura en el río después de ser completado el puente provisional de pilotes. La armadura original fué luego desmontada, reparada y reconstruída. La estacada que se ve sobre viaducto provisional y tramo caído se había usado como puente para pasar pasajeros y carga pequeña durante los días antes de ser completado el viaducto provisional y resumido el tráfico regular.

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On Dec. 1943 the deepening channel undermined the west bank foundation of the 160 foot span and caused bridge and foundation to overturn, upstream. Photo shows truss in river after temporary trestle had been completed. Truss was dismantled, repaired and re-erected. Long piling lying on top of temporary trestle and on fallen span had been used to carry a foot bridge, for passengers and small freight, during the last few days before temporary trestle was completed and regular train services resumed.

En la extraordinaria inundación de Diciembre 4 y 5 de 1949, se agrandaron los cauces de creciente establecidos desde hace muchos años. Se pueden notar cauces nuevos en la parte anterior y posterior al puente. En esta inundación el agua arrastró el tramo de 160 pies unos 2,000 pies río abajo. Nótese también el aguilón del martinete que se extiende hacia afuera del tramo restante. El trabajo de reparación se comenzó antes de que el río hubiera bajado completamente.

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The record flood of December 4th. and 5th. of 1949 enlarged flood channels which had been established many, many years. Note new flood channels both below and above bridge site. In this flood the 160 foot span was washed out and carried 2,000 feet downstream. Note boom of pile driver extending out from remaining span. Work had started before river had fully subsided.

Fotografía de cerca, tomada al mismo tiempo que la anterior, del puente de La Junta. El martinete se puede ver claramente y en el extremo este del puente se ven pilotes y otros materiales acumulados para la construcción del puente provisional. Véanse los árboles que han quedado de pie en el nuevo cauce del río.

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Close-up view of La Junta taken on same flight as above photo. Here pile driver can be seen clearly and, at east, end of bridge, is piling and other bridge material already accumulated for construction of temporary bridge. Note trees left standing in new river channel.

Las cuadrillas de reparación que venían de Limón se encontraron con este espectáculo del puente de La Junta en la mañana de Dic. 5, 1949.

Repair crews from Limon were greeted by this view of La Junta bridge on the morning of Dec. 5, 1949.

Las cuadrillas de reparación, viendo río abajo, podían apreciar lo que quedó del tramo de 160' que habían reconstruído no hacía más que seis años atrás.

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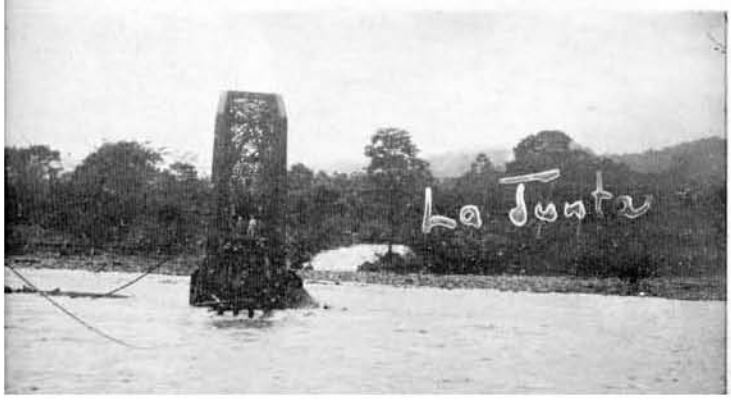
Looking downstream the repair crews could see the remains of the 160' span they had re-erected only six years previously.



Las cuadrillas de mantenimiento que llegaron de San José se en contraron con esta vista aproximadamente el 8 de Diciembre. Las cuadrillas de reparación de Limón ya habían comenzado la construcción del puente provisional a pesar de la dificultad de hincar los pilotes sobre un fondo de rocas, en una corriente sumamente rápida de un río todavía parcialmente crecido.

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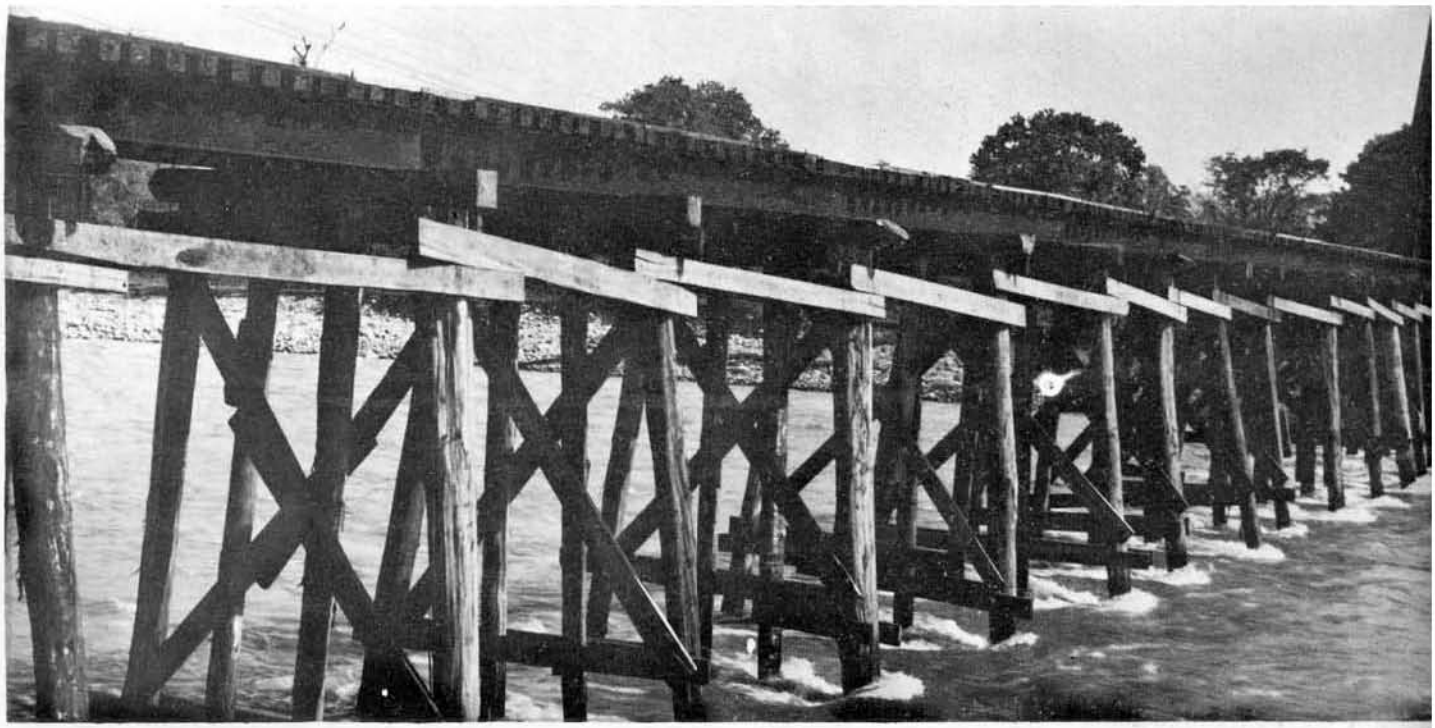
Maintenance men from San José had this view about Dec. 8th. The Limon maintenance crews had already started the temporary bridge in spite of the extreme difficulty of driving piling in a bed of boulders in the very rapid current of a river still somewhat in flood.



Once días después se había completado el puente provisional permitiendo así que pasara tráfico a velocidad reducida. Para restablecer este tráfico las cuadrillas trabajaron 24 horas diarias sin hacer caso a las condiciones del tiempo.

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Eleven days later the temporary bridge was complete and traffic moving over it at reduced speed. Crews worked through the 24 hours of the day and night, in rain or shine to re-establish traffic.

Esta armadura de madera midiendo 300 pies se usó para pasar tráfico hasta ser reemplazada con armadura de acero midiendo 250 pies.

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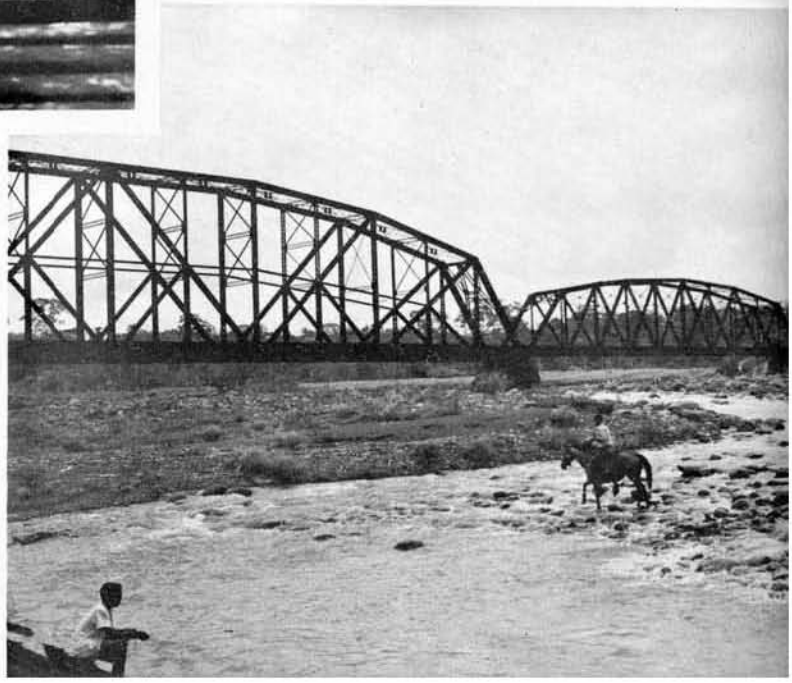
This 300 foot wooden trestle passed traffic until it was replaced with a 250 foot steel truss.



Unos meses después fué completada la armadura de 250' a un costo de $ 82,962.00 (₡ 470,398.00).

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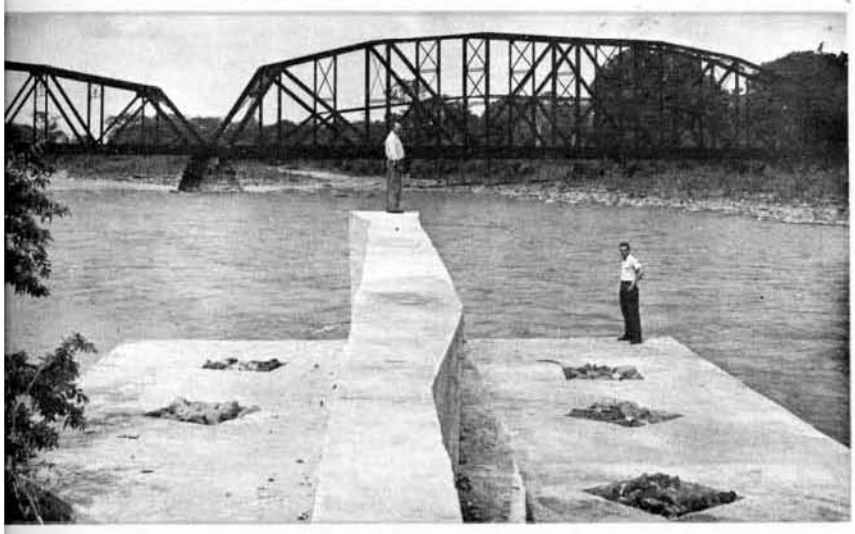
Some months later the permanent 250' truss is complete after an expenditure of $ 82,962.00 (₡ 470,398.00)

Vemos aquí un deflector bajo construcción que se colocó contra corriente en un esfuerzo para controlar la tendencia de la orilla izquierda del río de desgastarse violentamente durante las inundaciones. Nótese los rieles que se han clavado en el lecho del río y sobre los cuales se ha chorreado un bloque de concreto que formará el deflector.

In an effort to check the tendency of the left bank of the river to erode violently during floods a "deflector" is constructed upstream from bridge site. Here the deflector is under construction. Note rails driven into river bed on which concrete block is cast to form deflector.



Vista de la parte superior del deflector. Nótese que el ángulo está dirigido hacia el centro de la apertura total.

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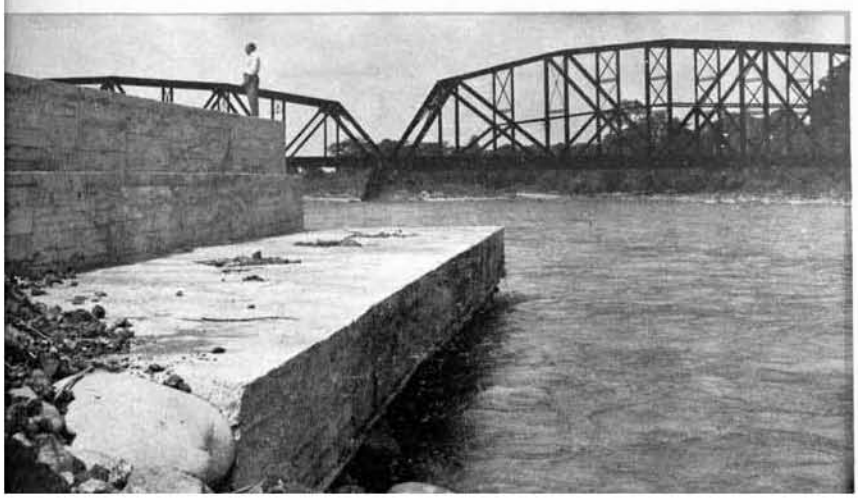
View along top of deflector. Note that angle points toward center of total opening.



Otra vista del deflector que se construyó a un costo de $ 11,076.89 (₡ 62,806.00) y en el que se usaron aproximadamente 600 yardas cúbicas de concreto.

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Another view of deflector which required approximately 600 cu. yds. of concrete and cost $ 11,076.89 (₡ 62,806.00).

Una pared de retención en la Milla 42½, hecha en 1935, falló en Diciembre 1949. La sección inclinada cayó pocos días después de haber tomado esta fotografía.

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This retaining wall at 42½ Miles, built in 1935, failed in December 1949. The leaning section fell a few days after this photo was taken.

Una nueva pared de retención fué construída para reemplazar la que se ve en la vista de arriba. Los bloques de concreto salidos descansan sobre pilotes metidos hasta el límite. Esta pared costó $ 13,148.00 (₡ 74,549.00).

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A new retaining wall was built to replace the one in above view. Protruding blocks rest on piling driven to refusal. This wall cost $ 13,148.00 (₡ 74,549.00).

LAS LOMAS

Las Lomas, sección entre Milla 46 y 47 paralela al río Reventazón, es uno de los lugares históricamente molestos del Ferrocarril. Los cerros visibles hacia la izquierda están formados de arcilla plástica que corre, con la consistencia de cemento mojado, durante períodos de lluvias fuertes y ha obstruído la vía hasta una profundidad de varios pies por más de una semana en varias ocasiones. Durante el año 1943 la vía fué levantada cuatro pies y se instalaron cinco aberturas de 30 pies, con canales hechos de concreto. Con estas mejoras la mayor parte del lodo ahora corre debajo de la vía hasta el río. Las inundaciones de 1949 lavaron el terraplén que aparece en esta fotografía. Una pared de retención hecha de concreto (no visible en esta fotografía debido a la vegetación), de 24 pies de altura y de 495 pies de largo, costó $ 28,701.00 (₡ 162,735.00), fué construída y rellenada por detrás para retener el terraplén de ahora. Los derrumbes de 1951 desviaron la mayor parte del río hacia la derecha de esta fotografía. El agua visible es solamente una pequeña porción del total del río.

LAS LOMAS

Las Lomas, section between 46 and 47 Miles, parallel to the river Reventazón, is one of the historically troublesome places on the Railway. The low hills, to the left in the photograph, are formed of plastic clay which flows with the consistency of a wet batch of concrete during periods of heavy rain, and has blocked the track to a depth of several feet for more than a week on many occasions. During 1943 the track was raised four feet, and five 30-foot openings, with concrete lined "chutes", were installed. With this improvement most of the mud flow now passes under the bridges into the river. The flood of 1949 washed out the embankment appearing in this photograph. A concrete retaining wall (not visible in this photograph because of vegetation), of 24 feet in height and 495 feet in length, cost $ 28,701.00 (₡ 162,735.00), was built and back-filled in order to hold the present embankment. The slides of 1951 diverted most of the river to the right of this photograph. The visible water is only a small portion of the total river.

Vista de la Milla 46½ hacia el Este en dirección a la estación de Las Lomas, cuyo techo es visible en la distancia en el centro de la fotografía.

Looking from Mile 46½ Eastward towards Las Lomas Station, whose roof can be seen in the distance, center of picture.

La construcción del túnel en Milla 48 ½ durante 1945 fué hecha en secciones, limpiando pequeños sectores de la trocha primero, luego colocando las formaletas (de acero y madera) para chorrear concreto y finalmente nivelando el derrumbe propiamente dicho, sobre el túnel ya construído. Fué hecho para proteger los trenes contra futuras caídas de rocas, árboles, derrumbes, etc. del risco de 750 pies de altura. El largo total fué de 1200 pies (con dos curvas), y el costo sumó $ 81,338.00 (₡ 461,186.00). Hay varias fotos de este túnel en relación con los derrumbes en Millas 46 ½ a 48 ½ de 1949.

The construction of the tunnel at 48 ½ Miles during 1945 was completed in sections, first clearing short cuts from the filled in right-of-way, then placing the forms and shapes (partly of steel and partly wood) for the pouring of the concrete and finally levelling the slide itself over the completed structure—in other words, a "cut and cover" tunnel. This tunnel was constructed to protect passing trains from rocks, trees, slides, etc. falling from the overhanging 750-foot cliff. Total length was 1200 feet (including two curves) and the total cost was $ 81,338.00 (₡ 461,186.00). This tunnel appears in several photos in relation to the slides at 46 ½ and 48 ½ Miles during 1949.