INTERSTATE COMMERCE COMMISSION

REPORT OF THE CHIEF, DIVISION OF SAFETY, COVERING THE INVESTIGATION OF THE ACCIDENTS WHICH OCCURRED ON THE WABASH RAILROAD AT ATTICA, IND, ON APRIL 5, 1914.

On April 5, 1914, derailments involving two trains of the Wabash Railroad occurred at Attica, Ind The first pertained to freight train No 69, in which there were no casualties, the second pertained to passenger train No 4, and was attended with loss of life and injury of a number of persons The first derailment resulted in the loss of a truck of a refrigerator car at the easterly end of the bridge over the Wabash River and the subsequent injury of the end post of the first span of the bridge The second accident consisted of the collapse of the bridge under train No 4, on account of the injury received in the derailment of the refrigerator car, and occurred about two and three-quarters hours after the first derailment

After investigation of this accident and of the circumstances connected therewith, I beg to submit the following report

Westbound freight train No 69 consisted of 49 cars and a caboose, hauled by locomotive No 2456, and was in charge of Conductor Jordan and Engineman Reibley, bound from Peru, Ind, to Decatur, Ill Train No 69 reached Attica, Ind, at 10 40 a m and departed at 11 09 a m The rear truck of the twelfth car in the train was derailed at a frog about 400 feet east of the eastern end of the bridge By the time the derailed car reached the bridge the derailed truck worked out from under the car, struck the batter post on the left-hand side of the end of the bridge and then went over the side of the bridge to the ground below

The train was brought to a stop with the disabled car about 200 feet west of the eastern end of the bridge, none of the other cars in the train being derailed Examination of the derailed truck showed all of the wheels to be in good condition and no defects were discovered on any other part of the truck The frog at which the car was derailed is located on a curve of 5°, and the empty refrigerator car was derailed as the train rounded this curve at a speed estimated to have been between 15 and 20 miles per hour Illustration No 1 is a view of the frog at which the derailment occurred, looking in the direction opposite to that in which the train was traveling at the time

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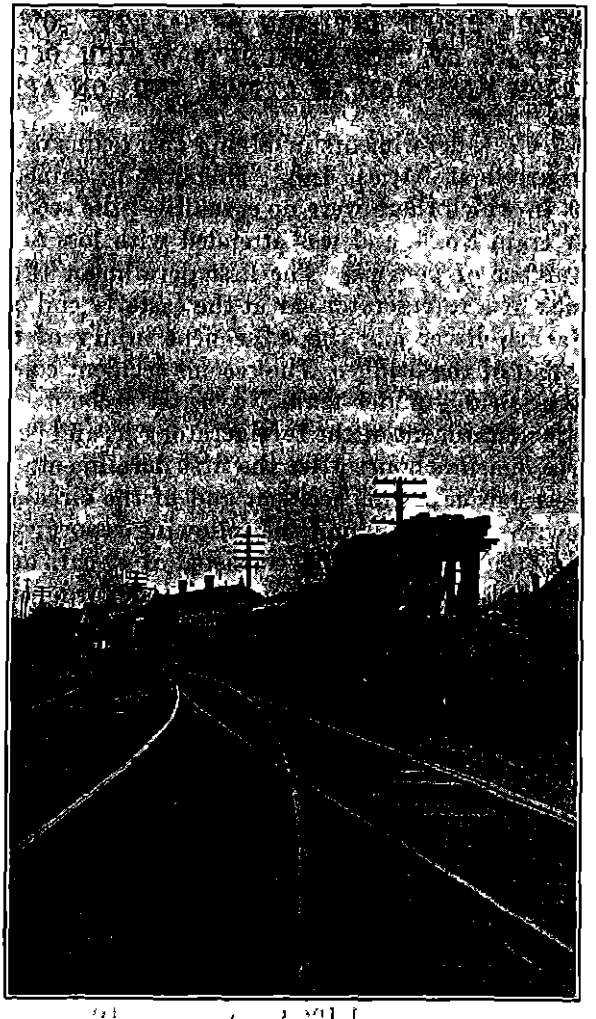


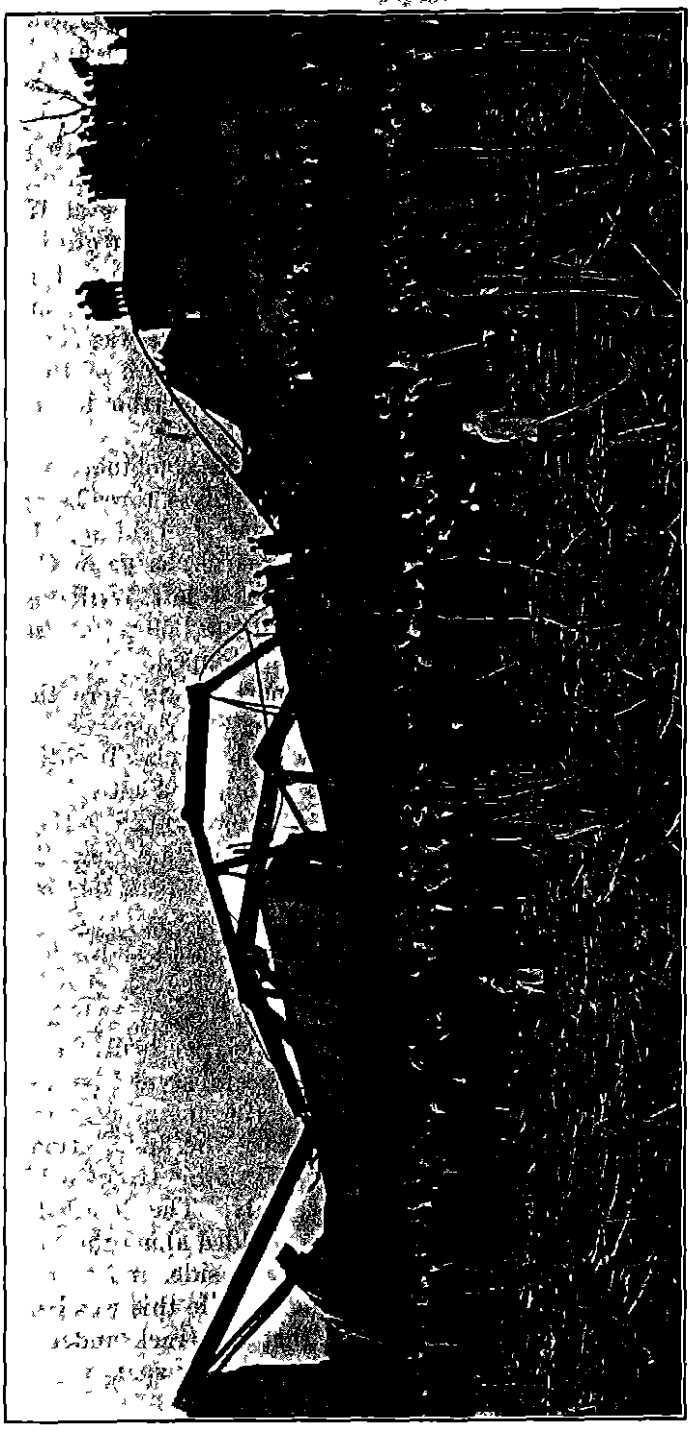
NO 1—VIEW OF FROG AT COVINGTON BRANCH LOOKING EAST

As soon as the train dispatcher was advised of the accident a train order was sent to the crew of eastbound passenger train No 4 at Danville, Ill , advising them that the track over the bridge was blocked After the disabled car had been removed from the bridge employees who were on the scene were of the opinion that it was safe for the passage of trains at slow speed, and the train dispatcher therefore sent a train order to the crew of train No 4 at Williamsport, Ind , directing them to approach the bridge carefully and to run very slowly over the damaged track Train No 4 had just reached the eastern end of the bridge when it collapsed under the weight of the train, the speed of which at the time was about 3 or 4 miles per hour This accident resulted in the death of the engineman, fireman, and one express messenger, and the injury of 83 passengers

Train No 4 consisted of one mail car, one combination car, one coach, one Pullman car, and one café car, the first three being of all-steel construction, while the two rear cars had steel siding The train was hauled by locomotive No 672, and was in charge of Conductor Young and Engineman Hull Train No 4 left Williamsport at 1 49 p m , and the accident occurred at about 1 58 p m , this being the time at which the engineman's watch stopped

The locomotive and mail and combination cars were thrown to the ground beneath the bridge and considerably damaged Illustrations Nos 2a and 2b are general views of the wreck It will be noted that the most easterly span of the bridge collapsed entirely, and that the eastern end of the span adjacent to it also dropped to the ground the western end resting against the top of the second pier The third car in the train, the coach, remained on this span, inclined at an angle of about 30°

Engineman Reibley, of train No 69 stated that as his locomotive was starting across the bridge he looked back, noticed dust flying, and thought that a brake beam had dropped down At this time the speed of the train was about 18 or 20 miles per hour He at once applied the emergency air brakes, saw that a car had been derailed, and went to the telegraph office to tell the operator to stop eastbound train No 6 at Williamsport, which is the first station west of Attica He then hauled the forward part of his train to Williamsport and returned with the locomotive only The derailed car was jacked up, a tie put under it and it was skidded along the rails to the eastern end of the bridge, jacked up on one side, and thrown down the embankment, clear of the main line While this was being done he looked at the bridge and noticed that the track under his locomotive, which was standing on the most easterly span, was depresed about 2 inches



NO 2a—GENERAL VIEW OF WRECK, FIRST SPAN OF BRIDGE

NO 2b —GENERAL VIEW OF WRECK SECOND SPAN OF BRIDGE

He talked about it with Conductor Tullis, of the crew of a wrecking train which had been summoned from La Fayette, Ind The conductor, however, said that the bridge had been that way before After the track had been cleared he backed off the bridge and stopped in front of the telegraph office At this time Conductor Jordan, of train No 69, gave him a signal to back up, saying that Track Supervisor Whitehead had said the bridge was all right and that a slow order had been issued Engineman Reibley further stated that he had no conversation with Supervisor Whitehead and did not talk with anyone about the condition of the bridge He did not think the bridge was unsafe, however, or he would not have backed his own locomotive over it He also stated that when backing over the bridge he did not feel it settle

Conductor Jordan, of train 69, stated that after the derailed car had been removed he notified Supervisor Whitehead and Section Foreman Younger that the car had been removed, and asked whether or not the bridge was all right Supervisor Whitehead turned to the foreman and asked him what he thought about it, and the latter replied that he had looked over the bridge twice and did not think that there was anything wrong with it, and he thought it was perfectly safe Conductor Jordan then said that he would let them come and Supervisor Whitehead said to let them come very slowly He then went to the office and told the operator to let train No 6 come very slowly, at a speed of not over 4 or 5 miles per hour Conductor Jordan also said he told the operator, while the track was being cleared, that the post was 8 or 10 inches out of line He further stated that he heard Engineman Reibley and Conductor Tullis talking and he heard them say that the bridge did not look safe, that it was out of line Conductor Jordan then looked along the rails and said to them that it did not look that way to him At this time locomotive No 2456 was standing on the bridge

Conductor Tullis, in charge of the La Fayette wrecking train, stated that he heard Conductor Jordan ask Supervisor Whitehead and Section Foreman Younger about the condition of the track and bridge and about allowing trains to cross Conductor Jordan then said that he would go to the office and notify trains Nos 4 and 6 to come, Supervisor Whitehead having said to let them come very slowly Conductor Tullis talked with Engineman Reibley and the engineman asked him if he did not notice the sagging in the bridge He saw that it was depressed, but on account of locomotive No 2456 standing at that particular spot he paid no further attention to the matter Conductor Tullis also said that inasmuch as locomotive No 2456 had stood on the bridge for half an hour and Engineman Reibley had said that he did not feel any sag under it, he thought it was perfectly safe for train No 4 to cross under a slow order

Track Supervisor Whitehead stated that while the freight car was being thrown down the embankment he went down under the bridge at which time locomotive No 2456 was standing on it He did not notice any settling of the bridge He looked at the batter post and thought that it had been bent about 6 inches toward the south He also examined the shoe, but did not see any sign of it having been moved He also made an examination of the top portal and knee braces, but found nothing wrong He stated, however, that he did not know much about bridges of the kind here involved, and he did not discuss the condition of the bridge with anyone except Section Foreman Younger He asked the section foreman what he thought about it and the foreman replied that it looked all right to him unless it was cracked below, but neither of them was able to discover anything After the track had been cleared he went over the bridge a second time with the section foreman He finished this examination before the section foreman had completed his examination, and when the foreman joined him, the foreman stated that there were no spikes or bolts broken anywhere and that everything was in perfect line Supervisor Whitehead then started to the office to make his report, but had just arrived there when some one informed him that the bridge had collapsed under train No 4 He further stated that after the freight engine had stood on the bridge, and had backed over it, he had no doubts about it being safe for the passenger train when running at slow speed There were 17 ties on the bridge which had been broken clear through in the center by the drawbar of the freight car dragging on them, while 117 were more or less shivered The damage done was not such as to necessitate immediate repairs before the passage of trains Supervisor Whitehead stated that the only question Conductor Jordan asked him was relative to the track on the bridge, and he told the conductor that it was all right—not a spike or bolt broken He denied the statements of Conductor Jordan and Tullis that he said anything about letting trains come, in fact, he did not know where the trains were, and was not yet ready to allow them to cross the bridge

Section Foreman Younger stated that after the freight car had been removed Supervisor Whitehead asked him to look over the ties and rails and see if there was anything out of line He did so, and found nothing wrong He noticed, however, that the batter post was cracked but did not look close enough to say whether or not any of the rivets were sheared He thought the bridge looked safe and so advised Supervisor Whitehead, who said that he did not himself see anything wrong Supervisor Whitehead then left and he went on about his work, supposing that he was going to send for a bridgeman At the time he was talking with Supervisor Whitehead

NO 3—VIEW OF DAMAGED END POST.

about the bridge some of the other employees were standing around near by, but he did not talk with any of them

Operator Zentmyre, located at Attica, stated that no one made any report to him or through him about the condition of the bridge and the only information he obtained was when he was directed by the dispatcher to go to the bridge and see what damage had been done He then told the disptacher that it was out of line and that he thought a bridge inspector should examine it After the track had been cleared Conductor Jordan came to the office and said that the track was clear and that a slow order should be put out Nothing was said at this time as to the safety of the bridge and no additional information was given to the dispatcher as to whether it was all right

Dispatcher Martin, on duty at the time the freight car was de railed, stated that Operator Zentmyre advised him over the telephone of the derailment, and then said that Conductor Jordan was there and would talk with him He talked with Conductor Jordan at three different intervals about the clearing of the track, nothing being said to him by the conductor as to the damage done to the bridge, with the exception of the ties Some time afterwards he told Operator Zentmyre to see what was going on and was informed by him that the batter post had been knocked out of line and that a bridgeman ought to be summoned This was the first information he had received of serious damage to the bridge He then told Chief Dispatcher Cullen what Operator Zentmyre had said, and they decided to have a bridgeman go to Attica He tried to secure one from Danville, but was unable to do so, and then decided that he would get Supervisor Whitehead from La Fayette Just before train No 4 reached Williamsport he was advised by Operator Zentmyre that Conductor Jordan had told him to let train No 4 come, looking out for engines and men at the eastern end of the bridge He knew Supervisor Whitehead was at Attica, but thought that the conductor represented the supervisor when he told him that it was all right for train No 4 to cross, for if anything had been wrong the supervisor would have told him about it He further stated that he had asked Operator Zentmyre if the bridge was out of line, and that the operator had said that all that he could see was that the batter post was damaged

Chief Dispatcher Cullen stated that when Operator Zentmyre told Dispatcher Martin that he thought a bridgeman ought to be summoned to examine the bridge, he arranged for one to be sent from Peru, Ind , on westbound train No 1 About 1 55 p m , he inquired how matters were progressing at Attica and was advised by Dispatcher Martin that the track was clear and that he had been told to let train No 4 cross the bridge at slow speed

NO 4—PHOTOGRAPH OF FRAGMENT OF COVER PLATE FROM WHENCE TENSILE TEST PIECES WERE TAKEN

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An inquiry into the circumstances attending the collapse of the bridge was conducted by Mr James E Howard, engineer-physicist, whose report immediately follows

The bridge over the Wabash River at Attica, Ind , two easterly spans of which fell on April 5, 1914, was a pin-connected, Pratt truss, through bridge It had six trussed spans ranging in length from 108 feet ¼ inch to 153 feet 6¼ inches center to center of pins There were also 12 plate girder deck spans at the westerly end, the girders having a length over all of 77 feet 8 inches each

It was built by the Pencoyd Bridge & Construction Co in 1897 The material was wrought iron, excepting certain tension members, which were of steel In the east span diagonals U1–L2 and bottom chord L2–L2 were steel, all other members being wrought iron

The design and fabrication of the bridge, so far as revealed, was satisfactory The unit stresses on the members under usual train loads were not excessive, but within the limits recognized as safe engineering practice No anxiety would be felt concerning the strength of the bridge under the service conditions which prevailed The end post which ultimately failed and caused the collapse of the bridge was stressed quite low and without doubt possessed a wide margin in strength in its original condition

The bridge was damaged by the derailed truck of a refrigerator car of westbound train No 69 The southeast end post of the east span was struck by this truck, resulting in serious injury to the member The disabled refrigerator car blocked the track This occurred at about 11 12 a m on the date above mentioned Two and three-quarters of an hour later the bridge collapsed under the weight of eastbound passenger train No 4

During this interval the cars which comprised freight train No 69 were removed from the bridge and the track cleared The rear cars were hauled off the bridge by another engine The forward cars were taken to Williamsport, the next station west of Attica, by the engine of train No 69 This engine then returned from Williamsport and backed over the bridge from west to east, pushing off the disabled refrigerator car The latter stood upon the second span of the bridge, where it had stopped after the loss of its rear truck The engine of No 69 remained on the Attica side of the bridge after the track was cleared

Eastbound passenger train No 4 left Williamsport about 1 50 p m , arriving at the bridge a few minutes later, entered upon it at a slow speed, and had nearly reached the east abutment when the bridge fell This occurred at about 1 58 p m The east span collapsed under the weight of this train Its falling apparently displaced the second span from its seat on the easterly pier, causing, it is believed, the fall of the latter

NO 5—DETAILS OF END POST WHICH WAS INJURED

The failure of the bridge was precipitated by the weakened condition of the southeast end post of the east span, which had been struck by the truck of the refrigerator car The damage done by this truck was a grave matter

The entire cross section of the post was either seriously injured or totally destroyed, none of the component parts of this batter post escaped without some injury Evidently the bridge itself barely escaped immediate destruction, so extensive was the injury received by the damaged member

Photographic evidence was secured showing the appearance of the end post after it had received the blow from the truck of the refrigerator car Illustration No 3 is reproduced from the photograph which was then taken Two of the principal parts of the post namely, the cover plate and one web plate were practically destroyed, while the other web plate was considerably bent In consequence of these injuries the post was incapable of offering normal compressive resistance in any of its parts No visual evidence was lacking at this time to indicate the seriously weakened condition of this important member

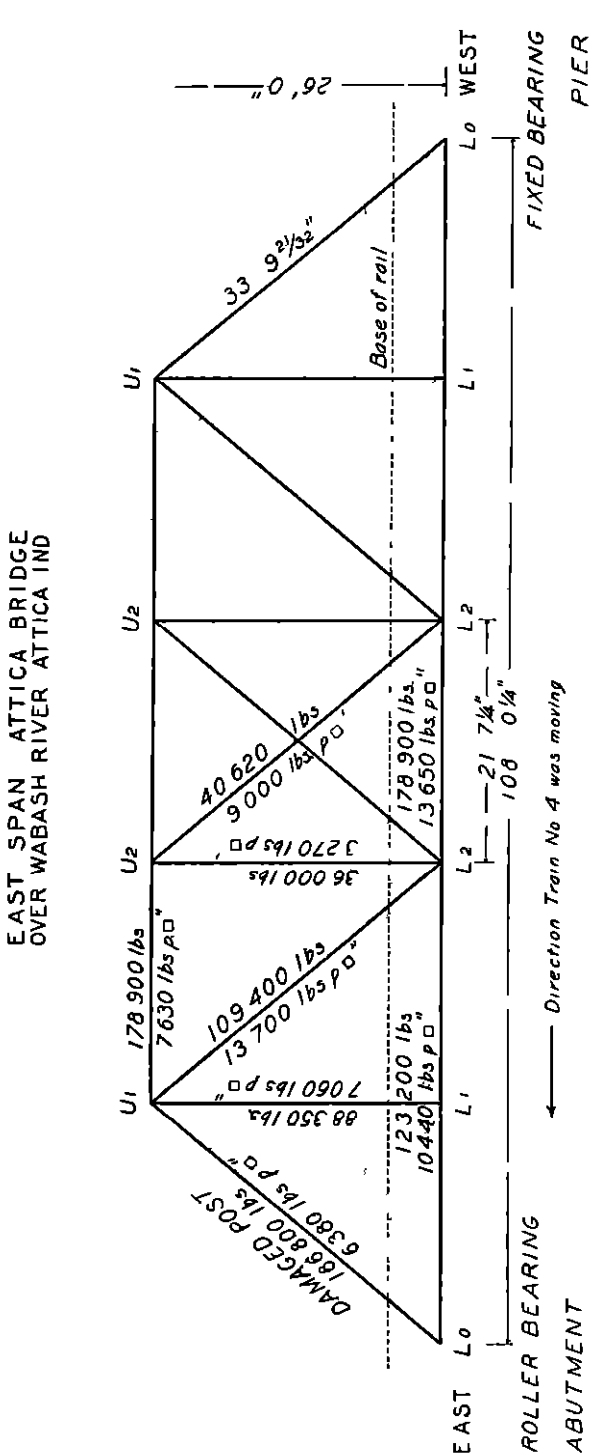
An examination of the photographic print showed that the cover plate was split along its south edge for a distance of 30 rivet pitches or 11 feet 3 inches Along its north edge it was split a distance of 8 feet 3 inches Across its width it was torn apart, all but a narrow strip on its south edge On the north edge the plate and outstanding leg of one of the 3 by 3 by $\frac{3}{8}$ inch angles was completely carried away for a short distance

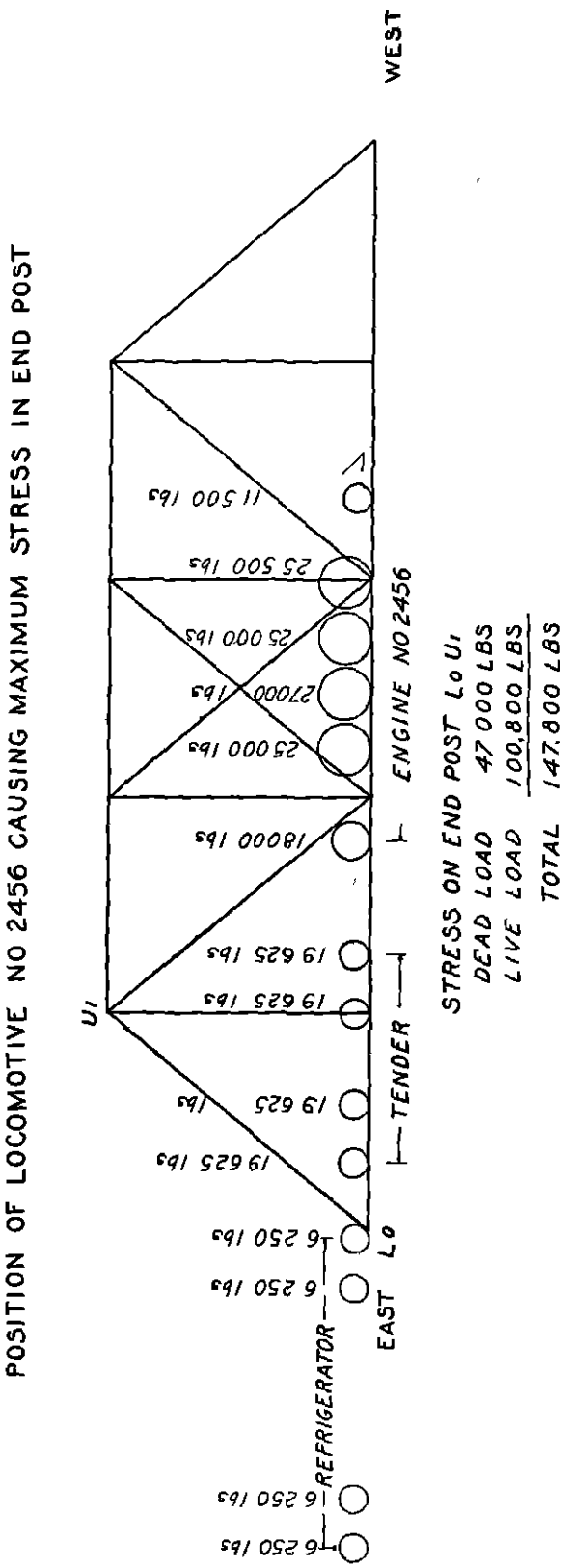
On the north side the web was split and distorted It was evident from its appearance that the south web and angles were also considerably buckled The injury to the post could hardly have been greater

In explanation of the extensive destructiveness caused in this member by the derailed truck, attention will be called to the fact that it was made of wrought iron, in which there was practically no toughness in the metal in the direction taken crosswise the grain

The following table shows the results of tensile tests on the metal of the cover plate The fragment from whence these specimens were taken is shown by figure No 4 and is believed to have been a part of the end post in question

In a crosswise direction the iron displayed low strength and was further characterized by fracturing without the development of appreciable extension The tensile strength in this direction did not reach the normal elastic limit of the material Lengthwise the iron displayed tensile strength usual to wrought-iron plate


EAST SPAN ATTICA BRIDGE
OVER WABASH RIVER ATTICA IND
26' 0"
WEST
FIXED BEARING
PIER
Base of rail
33 9 21/32"
U1
U2
L0
L1
L2
178 900 lbs
7630 lbs p □"
109 400 lbs
13 700 lbs p □"
36 000 lbs
3270 lbs p □"
40 620 lbs
9000 lbs p □"
178 900 lbs.
13 650 lbs p □"
21 7¼"
108 0¼"
88 350 lbs
7060 lbs p □"
123 200 lbs
10440 lbs p □"
DAMAGED POST
186 800 lbs
6380 lbs p □"
EAST
ROLLER BEARING
ABUTMENT
Direction Train No 4 was moving
Stresses for Locomotive No 672 and forward truck Postal Car No 164
NO 6


EAST SPAN, ATTICA BRIDGE
POSITION OF LOCOMOTIVE NO 2456 CAUSING MAXIMUM STRESS IN END POST
WEST
EAST
U1
L0
11 500 lbs
25 500 lbs
25 000 lbs
27000 lbs
25 000 lbs
18000 lbs
19 625 lbs
19 625 lbs
19 625 lbs
19 625 lbs
6 250 lbs
6 250 lbs
6 250 lbs
6 250 lbs
REFRIGERATOR
TENDER
ENGINE NO 2456
STRESS ON END POST L0 U1
DEAD LOAD 47 000 LBS
LIVE LOAD 100,800 LBS
TOTAL 147,800 LBS
NO 7

Tensile tests of specimens from cover plate, southeast end post, Attica bridge, wrought iron plate

Direction tested	Dimensions		Section al area	Elastic limit		Tensile strength		Elongation in 8 inches	
	Width	Thick ness		Total	Per square inch	Total	Per square inch	Inches	Per cent
	In	*In*	*Sq in*	*Lbs*	*Lbs*	*Lbs*	*Lbs*		
Lengthwise	2 480	0 368	0 913	40,530	44,400	47,170	51,660	0 53	6 6
Lengthwise	2 478	364	902	40,900	45,340	50,210	55,660	47	5 9
Crosswise	2 482	370	918			28,620	31,200	(1)	(1)
Crosswise	2 482	368	913			31,740	34,760	(1)	(1)

[1] Inappreciable

Appearance of fractures fibrous, lamellar
Bending tests were made on the stems of the crosswise specimens The metal fractured crosswise the grain without bending through an appreciable angle

To expedite clearing away the wreckage, dynamite was used to separate the fallen members at their joints The fragment which furnished the material for these tests was bent, either at the time of the collapse of the bridge or subsequently when dynamited No shattering effects were noticeable on the parts used, hence it is believed the tensile tests fairly represent the quality of the material

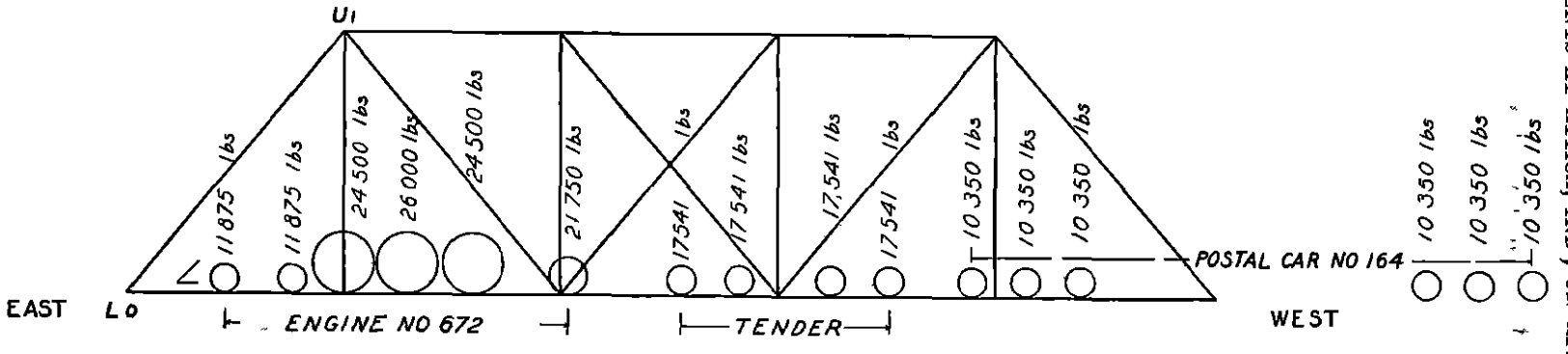
Figure No 5 is a drawing of the end post, showing the details of its construction, which was made up of a cover plate, two web plates, and four angles The fourth side was latticed The pins were placed in the middle of the width of the webs Its ratio of slenderness was 72 l/r, which places it among relatively short columns An ultimate compressive strength of at least 30,000 pounds per square inch would be expected in this post in its original condition

Diagram figure No 6 shows the stresses which would come upon the different members of the east span under the combined weight of the locomotive of train No 4 and the forward truck of the postal car, which was in the train next behind the tender The computed stress on the post caused by this load was 6,380 pounds per square inch This must be regarded as a very moderate stress for the intact member to sustain The stresses entered on this diagram, and others which accompany herewith, are from data furnished by the Wabash Railroad Co

Diagrams Nos 7 and 8 show the wheel loads for each of the two locomotives involved in this accident, the locomotives being sketched on the truss in position of maximum loading On these diagrams are entered the maximum loads on the end post in question, or the maximum load which would come upon it had the bridge been capable of sustaining the weight of train No 4

EAST SPAN ATTICA BRIDGE

POSITION OF LOCOMOTIVE NO 672 CAUSING MAXIMUM STRESS IN END POST



STRESS ON END POST Lo U1

DEAD LOAD	47,000 LBS
LIVE LOAD	139800 LBS
TOTAL	186800 LBS

NO 8

On diagram No 7 it will be seen that locomotive No. 2456, of train No 69, had at this time just pushed the refrigerator car off the east end of the bridge The locomotive alone stood on the bridge at the time With this locomotive on the bridge the sum of the live and dead loads on the post was 147,800 pounds This load represents the highest which the bridge was called upon to sustain, during the interval succeeding the injury to the batter post and preceding its loading by passenger train No 4, which latter train applied a heavier load

Diagram No 8 shows the position of locomotive No 672, of train No 4, giving the maximum load on the end post The forward truck of postal car No 164 was upon the east span of the bridge at this time The rear truck of the car was upon the second span In this position the load upon the end post would have been 186,800 pounds, or 39,000 pounds more than the load caused by the freight locomotive Train No 4 was proceeding slowly at the time of the collapse and, as it appears from the testimony, the locomotive had nearly or quite reached the position indicated on the diagram when the structure gave way

The falling of the second span, as previously stated, was doubtless a secondary feature It was apparently forced off the pier at its east end in a northerly direction, its failure not being attributed to any structural defect, but to its having been displaced by the falling of the adjacent truss

Making a comparison of the two locomotives involved in this accident with respect to their total weights, it is found that the weight of the freight locomotive was 421,000 pounds, that of the passenger locomotive, 398,000 pounds The tender of each is taken as fully loaded in these figures The total loads which were put upon the bridge in its disabled state were as follows Freight locomotive, plus the weight of the empty refrigerator car, 471,000 pounds, passenger locomotive, plus the weight of one truck of the postal car and minus 16,672 pounds, deducted for partial loading of its tender, 443,428 pounds This deduction for partial loading of the tender was made by the Wabash Railroad Co in its computation of stresses, and will be followed in this comparison This shows a difference of 27,572 pounds, representing the amount which the combined weight of the freight locomotive and refrigerator car exceeded that of the passenger locomotive and one truck of the postal car

It will be understood, however, that it is not a question of total load which was on the bridge at any given time with which we are principally concerned, but the manner of its distribution, by reason of which a maximum stress was put upon the post under consideration Part of the load necessarily went to one end of the bridge and part to the other The magnitude of the load which reached the injured member is the essential feature

The locomotives of these two trains faced in opposite directions, one toward the east, the other toward the west Under these conditions of loading the passenger locomotive with the forward truck of the postal car, stressed the end post higher than the freight locomotive At the time the highest stress came upon the end post during the period of loading with the freight locomotive, the refrigerator car was in fact not on the bridge, but just off the east span on the abutment To the circumstance that the freight locomotive was headed westerly instead of easterly, is due the fact that the bridge did not collapse under its weight

The member which was injured and led to the collapse of the bridge was a compression member, therefore the material used in its fabrication will be judged of with respect to its fitness to resist compression loads For such stresses it is probable that the post would compare favorably with those made of ordinary grades of structural steel used in bridges and buildings of current fabrication The results of the tensile tests do not lead to criticism of the material for compressive stresses, yet explain why the post was so badly injured by the blow from the truck, and why the material tore so readily instead of being distorted only

Originally there was a surplus of strength in the end post, and notwithstanding its seriously damaged condition it successfully carried the lesser loads which were put upon it until overcome by the load of the passenger train So manifest was the injury which it received, as shown by the photographic print, that comments upon its weakened state, as it existed at the time train No 4 was permitted to come upon it, seem superfluous No words of warning could have been more emphatic or impressive to the senses than should have been occasioned by the appearance of the post itself, as it was seen by those present during the interval of time which elapsed after the injury had been received and prior to the time train No 4 reached the bridge

In conclusion it appears

That the derailed truck of a refrigerator car of freight train No 69 struck the southeast end post of the bridge at Attica, Ind , seriously weakening the member

That the cover plate of this end post, one web plate, and two angles were practically destroyed, while the other web plate and its two angles were badly bent and their compressive resistance much impaired

That the weakened condition of the bridge was clearly manifest and of a nature so serious that its dangerous condition should have been realized and traffic immediately suspended

That the lives of employees were placed in jeopardy by backing the locomotive of freight train No 69 over the weakened span

That passenger train No 4 was permitted to enter upon this weakened span, under which it collapsed, attended with loss of life and personal injuries

That computations of the loads which were received by this end post showed a maximum stress of 147,800 pounds, due to the weight of the locomotive of freight train No 69

That the maximum stress due to the locomotive of passenger train No 4, together with the forward truck of postal car No 164, was 186,800 pounds

That the stress on the end post due to the weight of the passenger train exceeded that of the weight due to the freight locomotive by the amount of 39,000 pounds

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It is apparent that following the derailment evidence of serious injury to the end post was clearly visible before either the engine of train No 69 or train No 4 was permitted on the bridge and steps should have been taken to have the structure examined by a bridge inspector before allowing trains to proceed over it The necessity for such examination was recognized, and an inspector had been arranged for Owing to conflict in the evidence, responsibility for permitting the bridge to be used in its weakened condition can not be definitely placed Track Supervisor Whitehead was apparently in charge, but he did not personally notify the dispatcher that it was safe for train No 4 to proceed

It is probable that those in authority on the ground erroneously concluded that the bridge was safe for the passage of train No 4 on account of having withstood the heavier weight of the engine of train No 69, which backed over the bridge pushing off the damaged refrigerator car As appears from the report of Mr Howard, however, the end post was strained more by train No 4 than by the freight engine, due to the opposite directions which the engines faced, affecting the distribution of the load on the bridge The engine of train No 4, therefore, placed a greater load on the damaged end post than did the engine of train No 69, resulting in collapse of the structure

Respectfully submitted

H W Belnap,
Chief, Division of Safety
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