# 'Rolling Thunder' and Bomb Damage to Bridges



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*Intelligence tackles an old problem in a new form.*

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The program known as Rolling Thunder, a systematic but restrained air offensive against selected economic and military targets in North Vietnam, began on 2 March 1965. The basic objectives of Rolling Thunder were to reduce the ability of North Vietnam to support the Communist insurgencies in South Vietnam and Laos; to increase progressively the pressure on North Vietnam to the point where the regime would decide it was too costly to continue directing and supporting the insurgency in the south; and to bolster the confidence and morale of the South Vietnamese. As the days of the air campaign over North Vietnam stretched into months, the requirement developed in Washington and particularly in the White House for independent assessments of the results. As a consequence, CIA was asked to make its own assessment of the bombing campaign as well as to join the Defense Intelligence Agency (DIA) in the preparation of an analysis for the Secretary of Defense. The work on bomb damage to bridges, which is discussed in this paper, is one example of the reporting on the Rolling Thunder program. Although the extent of damage and the cost of repair are the principal topics discussed here, the White House was equally concerned to find out how much time would be needed to restore lines of communication (LOCs).

# Background

North Vietnam's major contributions to the war in the south have been its military manpower, its function as the control center for the insurgency, and its function as the logistics funnel through which materiel, mostly from the USSR and Communist China, has moved into South Vietnam. Consequently the attainment of the first objective of Rolling Thunder hinged almost entirely on the ability to impede or stop the flow of men and supplies from North Vietnam to South Vietnam. Although a number of different target systems were taken under attack, the Rolling Thunder campaign was essentially and at times almost exclusively an interdiction program. A standard bombing strategy to achieve such a goal was to stop or slow military traffic in rear areas by interdicting critical choke points along heavily used LOC's. Bridges of course qualify as such, and during Rolling Thunder more attack sorties were flown against bridge targets than against any other fixed target system.

As the bombing campaign progressed, policy-makers and high-level Presidential advisors started asking the intelligence community to assess the effectiveness of the effort. Among the questions posed were those on the status of damaged bridges and North Vietnamese countermeasures to bypass the bridges. The Secretary of Defense specifically wanted to know the number of bridges damaged, the estimated cost of repairing the damage, whether or not the flow of traffic south was being effectively impeded, how quickly the bridges could be restored, and the net impact on logistics capabilities. Answering these questions proved to be a knotty problem.

# Number of Damaged Bridges

In one of his columns in 1966, Art Buchwald pointed out that available statistics suggested that the US apparently had destroyed all of the bridges in North Vietnam many times over. He concluded that we must be "dropping our own bridges on North Vietnam and then bombing them." Buchwald's quips contained much truth. During the early months of the bombing campaign, depending on the sources being used and the degree of discrimination exercised, one could get an extraordinary variety of estimates of the total number of destroyed bridges in North Vietnam, ranging from as low as 657 to as high as 7,000. When total "bridge-kills" began approaching these incredible numbers, it became apparent that a new basis of intelligence assessment was in order. Before we could get at the matter of the true extent and nature of the damage and the impact of the program on the enemy's logistic activities, however, there were fundamental problems to be resolved including such basic questions as when is a bridge a bridge. Within CIA the job was given to the Construction Branch of the Office of Economic Research (OER ).

Analysts from OER, in consultation with DIA, discovered that early estimates of destroyed bridges were compiled almost exclusively from pilot reports. Now it is very difficult for a pilot to assess accurately the results of a strike while traveling at high speed and when the target area is obscured by smoke and dust. To narrow the credibility gap concerning the number of bridges damaged, OER analysts decided that the only reliable method was to use "hard" evidence provided through the eye of a camera rather than the fleeting evidence provided through the eye of a pilot. Starling in September 1965, therefore, a special task force consisting of personnel from OER and DIA and the Imagery Analysis Service (IAS) spent many man-hours reviewing all reconnaissance missions flown over North Vietnam searching for damaged bridges. This intensive search, completed in March 1966, revealed that 216 bridges actually had been destroyed during the first year of the interdiction campaign, compared with 657 in what were at that time the currently most conservative assessments. The figure rose to a high of 541 destroyed bridges by the end of the bombing program in October 1968.

Once the principle of using aerial photography was adopted as the sole source of information from which to make hard estimates, a group of CIA/IAS photo interpreters was assigned the tedious but important task of scanning all photographic missions looking for damaged bridges. Each bridge crossing was measured and cataloged, and a photograph of each was prepared for later analysis by OER. During the three years of bombing, personnel in the Construction Branch analyzed and filed over 2,500 prints covering some 600 bridges. These photographs provided the basic input for answering many questions posed by the Department of Defense and the White House on the effectiveness of the interdiction campaign.

## Conceptual Problems

Before an accurate bridge count could be attempted, a number of conceptual problems had to be solved. One such problem was how to define precisely what constituted a bridge. It appeared somewhat irrational to place a 10 or 20 foot water crossing in the same category as the 1,000 foot bridge at Viet Tri or the mile-long Paul Doumer bridge crossing the Red River near Hanoi. Many of the smaller crossings could more accurately be described as culverts, causeways, or simply improved fords, and thus were excluded from the bridge count. Another problem that arose concerned the definition of a "destroyed" or "damaged" bridge. Mere cratering of bridge approaches or "near misses" in adjacent rice paddies could not be counted as damage serious enough to interdict a water crossing. The concept of Severe Damage Occurrence (SDO) was developed, therefore, to assess bomb damage. An SDO was defined as damage sufficiently severe to deny a crossing to users until a significant amount of repairs had been performed, requiring considerable time, materials, and labor. For example, serious damage would include a dropped span, a destroyed pier, or a destroyed abutment. Holes in a deck, cratered approaches, twisted superstructure, or a slight shifting of spans was not considered serious damage.

In 1967 a study of the effectiveness of bombing bridges in North Vietnam was made by OER analysts. A sample of 46 Joint Chiefs of Staffs (JCS) target bridges which had severe damage was used. The study covered the period from the start of bombing through January 1967. Photography provided most of the information for the assessment of the extent of damage to the bridges, and bomb damage assessment reports provided data on the volume and types of ordnance used. The study revealed that there were 249 hits out of 11,744 bombs dropped, for an average of one hit for every 47 bombs dropped In other words, slightly over 2 percent of all bombs dropped succeeded in damaging a bridge to such an extent that it needed extensive repairs.

# Cost of Repair

In addition to an accurate count of interdicted, bridges, policymakers wanted to know what it would cost to rebuild destroyed bridges to their original state. The best method to arrive at an aggregate cost figure would to be use North Vietnamese costs for bridge construction in terms of dongs and then convert the dong figure into US dollars according to an appropriate dong-dollar construction ratio. This ideal approach could not be followed because of our complete lack of statistical data on North Vietnamese construction costs. The procedure finally adopted was therefore a compromise, but it did enable the calculation of relative values.

The costing methodology involved selecting a number of US bridges for which construction costs were available and which were similar in design to many bridges in North Vietnam. Unit costs for labor, materials, and equipment were calculated and then adjusted to reflect construction inputs available to the North Vietnamese. The result of these calculations indicated that $700 per lineal foot would provide an order of magnitude for the cost of building permanent highway bridges in North Vietnam.[1] This figure was tested by referring to reports from a prominent US engineering firm that had estimated the construction cost of building 205 highway bridges in Southeast Asia. These estimates averaged $740 per lineal foot, which was within about six percent of the figure obtained by the OER method.

In estimating the cost of repairing damage to a bridge, the structure was broken down into its component parts; abutments, piers, and superstructure. Relative costs for each of these components were then derived for each damaged bridge, and only the destroyed components were considered in estimating the cost of both temporary and permanent repair or replacement. The estimated total cost figure for rebuilding all bridges to their original state rose from about $10 million after the first year of bombing to over $30 million by the end of the Rolling Thunder campaign.

A similar approach was used in estimating the cost of construction and repair of temporary wooden bridges. These crude, relatively cheap structures of simple design were easy to build. It was calculated that the cost of construction averaged $50 per lineal foot and required 30 men for each 20 feet of bridge under construction. During the entire campaign, 292 temporary wooden bypass bridges were built at an estimated cost of $10,000,000.

In addition to bridges, over 500 bypasses of other types were constructed. These consisted of pontoon bridges, causeways, ferry slips and fords, at a cost of approximately $3,000,000. In this instance, the real burden was the requirement far large numbers of personnel to construct, maintain, and repair these crossings. Manpower requirements were far more burdensome than material costs, especially during 1986 and early 1967. In these years it is estimated that 72,000 full time and nearly 200,000 part time workers were required to keep the LOC's open. At the same time there were several Chinese engineer battalions totalling more than 20,000 troops working on the roads and railroads north of Hanoi.

# Countermeasures

One of Newton's laws states that "for every action there is a reaction that is equal in magnitude but opposite in direction to the action." Three years of examining photographs of destroyed bridges indicated that this dictum also applied to the North Vietnamese program to counter the effects of the bombing. During the early months of the Rolling Thunder program, the North Vietnamese were unable to repair LOC's as fast as they were damaged. It took them several months to organize their labor force and pre-position materials near anticipated areas of attack. After two years of bombing, however, they had so organized their construction effort that they built and repaired bridges and other bypasses faster than the crossings could be interdicted. Their modus operandi was to rely on labor intensive repair techniques and local building materials. They stockpiled stone, bamboo, and timber near expected targets and assigned construction personnel to nearby semi-permanent work camps to maintain and repair allotted segments of the LOC's. As the campaign neared its end the North Vietnamese countermeasures had been perfected to a point that many of the serious damage occurrences could be repaired in hours rather than days. The main emphasis in the North Vietnamese countermeasures program, and the main reason for its ultimate success, however, was the strategy of building multiple bypasses for all important crossing points.

# Types of Bypasses

The type of bypass chosen for construction was generally determined by the nature of the terrain, and the number of bypasses constructed at a crossing point depended on the importance of the route. Fords were common in the mountainous regions where streams are shallow and narrow. Cable bridges with removable decking were usually constructed where the stream banks were high, and where the streams were fairly narrow but deep. Temporary wooden bridges, pontoon bridges, and ferries were predominant in the lowlands where the rivers were too wide and deep to ford. Constructed fords were the most common means to bypass damaged highway bridges, especially in the early months of the bombing campaign. They could be quickly built and repaired with local materials. They could, of course, only be employed at shallow crossings where banks were low. The construction of alternate bridges was also an effective countermeasure. The virtue of these bridges was their simplicity.

They were built from salvaged components and locally procured timber, lumber and rock. Because of their short span design they were easy and quick to build and repair, but difficult to destroy. One innovative variety which appeared, unique to North Vietnam, was the cable bridge, which proved to be a very effective method for repairing or bypassing highway bridges. Parallel steel cables drawn taut between anchorages on each bank were covered by prefabricated wood sections which provided a removable deck. The only method of interdiction was to bomb the cable anchorages buried in the river banks, which proved to be a most difficult assignment. Ferries and pontoon bridges were used at the largest water crossing. Ferries are a relatively inefficient means of rapidly moving a large volume of goods and were used mainly to carry rail traffic over major river crossings. Pontoon. or float bridges proved to be effective bypasses for truck traffic. They were difficult to interdict because they could be divided into sections and hidden along river banks.

# Number of Bypasses

The trend of the North Vietnamese countermeasures effort can be illustrated by the change in the average number of bypasses built for important JCS-targeted bridges. Repeated aerial photography indicated that the numbers steadily increased, as shown in the following tabulation:

| Type of Bypass | Through May 67 | Through Sept. 67 | Through Dec. 67 | Through Sept. 68 |
|---|---|---|---|---|
| Total number of damaged JCS-targeted bridges[2] | 46 | 52 | 54 | 54 |
| Total number of bypasses | 99 | 157 | 175 | 200 |
| Of which: | | | | |
| Fords (including causeways and culverts) | 18 | 22 | 22 | 22 |
| Alternate bridges | 26 | 36 | 38 | 49 |
| Cable bridges | 9 | 14 | 15 | 16 |
| Ferries and pontoon bridges | 46 | 85 | 100 | 113 |
| Average no. of bypasses per bridge | 22 | 3.0 | 32 | 3.7 |

## Why Bypasses?

The North Vietnamese preoccupation with the construction of bypasses was a well-conceived response to the bombing campaign. In effect, they dispersed their LOC chokepoints just as they had dispersed their POL storage facilities and other targets which gave their system a built-in redundancy that greatly lessened its vulnerability to effective air attack. Multiple bypasses at a single crossing generally were placed so far apart that the dispersion pattern of a bomb stick would bracket only one bypass at a time. (See Figure 1.) Therefore, where it may have taken one raid to interdict a crossing during the early days of the bombing program, in later periods it took two or three raids to interdict the same crossing. The most important rail/ highway crossing in North Vietnam is the Paul Doumer Bridge over the Red River at Hanoi; at one time it was supported by 20 bypasses. Multiple bypasses thus increased the probability that at least one crossing at a site would always remain serviceable. In addition, because it normally took as much ordnance to interdict a bypass as to interdict the original bridge, the cost of bombing a water crossing in North Vietnam increased much faster than the cost of repairing it with cheap local materials. At the same time, US aircraft were subjected to the same risks when attacking bypasses as when attacking the original bridge.

## After the Bombing Halt

The story of estimating bomb damage and analyzing North Vietnamese countermeasures abruptly ended on 31 October 1968 when the bombing program was stopped. However, the expertise and voluminous files that were built up over three years of work are still useful These assets now provide the basis for estimating the extent and speed of reconstruction rather than the cost and effect of destruction. Also, they will provide a valuable data base for the historian or anyone doing a post-mortem on the Rolling Thunder program.


Figure 1. Bypasses at Phuong Din, North Vietnam.

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# BIBLIOGRAPHY

1 Highway bridges were used as the basis for all estimates. The cost of reconstructing railroad and combination (rail/highway) bridges was obtained, generally .speaking, by doubling highway bridge costs. Railroad bridges are designed to carry much heavier loads than highway bridges, which means a significant increase in the volume of materials used and much heavier foundations.

2 Joint Chiefs of Staff (JCS) targets were those designated under ground rules established by the White House in an effort to avoid possibilities of escalating the war, and those considered most crucial to its successful termination.

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