THE STORY OF GRAND RIVER BRIDGE AND ITS DEMISE

By: Philip Helwig, M.Sc. (Hydraulics), P.Eng (Retired), St. John's (NL), September 12, 2023

About the author:

Phil Helwig has had a varied engineering career in both education (8 years) and in design and technical management (53 years). Most of his formative experience was with a small company in Newfoundland (ShawMont) which valued versatility, as a result Phil was able to develop expertise that goes well beyond the skills set normally associated with his formal area of competence, as a hydrotechnical specialist. His main area of expertise is in the fields of hydropower and water resources where he has been involved in investigations, economic planning and project optimization studies and detailed design. He has been responsible for several innovations in Canadian practice: notably, the design of Cat Arm Hydel unlined pressure tunnel (head = 386 m) and "bathtub overflow spillway" and design of Hinds Lake Power Canal based on natural armouring (the first application of this technology in hydro design worldwide) and the design of Paradise River double curvature arch dam – only the third arch dam ever built in Canada. More recently from his experience in South Asia, he has developed expertise in design of hydraulic structures to handle water borne sediment. His latest interest is in the field of eco-hydraulics. In 2004, Phil formed his own company, Helwig Hydrotechnique Ltd. and has worked on four continents in three languages. Technology transfer is an integral part of all Phil Helwig's assignments.

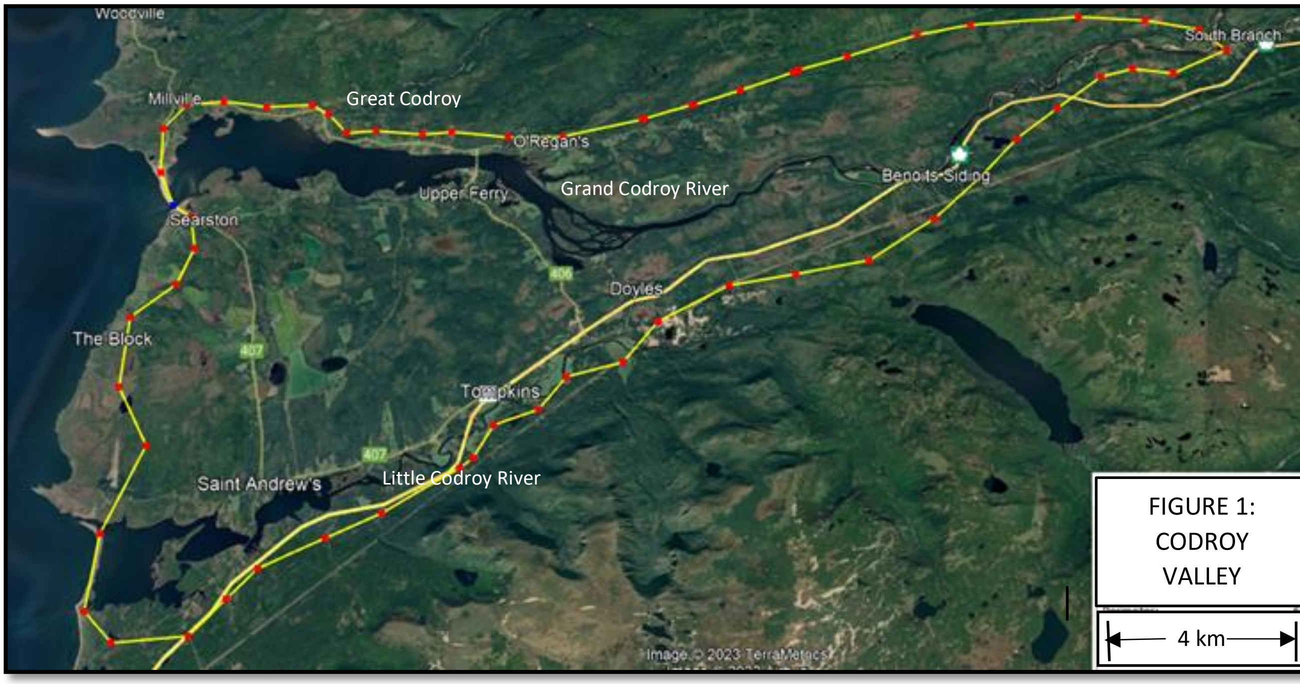
> *"I was one of the early COV/CUSO volunteers. I had two assignments, the first in Ceylon with the Dept of Public Works on planning and investigations for roads in the Kandyan (Mountain) area linking remote villages to larger centres (1962-63). This assignment required working in the Sinhala language. My second assignment was as Senior Lecturer at Balwant Vidyapeeth Rural Institute a community college educating mainly village youth as civil engineering technicians (1963-64). I came to Newfoundland to help set-up the engineering co-op program, the third such program in Canada at that time (1970)."*

Introduction:

I became interested in the story of Grand River Bridge through my ice engineering studies and discovery of the role ice played in the destruction of this bridge on January 15, 1978. My intention here is to preserve this important story for the annals of Newfoundland and Labrador engineering history. However, as I delved deeper into the subject, I realised that the geographical and historical settings were equally interesting. So, I have decided to introduce my story with accounts of the geography of Codroy Valley and history of the settlers in the Valley, and then go onto my main story about Grand River Bridge - its construction and demise.

The Place:

Codroy Valley ("the Valley") nestles between two mountain ranges, the Anguille Mountain to the north and the Long Range Mountains to the south, and the Gulf of St. Lawrence to the west. The land between these mountains is formed from fluvioglacial deposits transported from the interior plateaus of S.W. Newfoundland by a glacier that once flowed through the Valley. Two main rivers flow through the Valley, the Grand Codroy River and the Little Codroy River. Both rivers run separately to the sea and define a broad zone of rolling country between them, which hosts most of the small villages and farms of the Valley. Estuaries have developed at the outlets of both rivers. See Figure 1.



Wetlands within the Grand Codroy Estuary support a wide variety of bird life both resident and migratory, including: song birds, shore birds and water fowl. It has been designated a wetland of international importance under the Ramsar Convention. Over 100 species of birds have been observed in the Valley which has become an area of great interest for bird watchers. The Valley is blessed with fertile top soil derived from decomposition of forest and plant litter. It also benefits from a favourable climate with warm summers, ample rainfall, and an adequate growing season (1,394 ^{o}C.days above 5^{o}C/41^{o}F and mean annual precipitation of 1505 mm/59 inches). It is reputed to be the best region for agriculture on the Island of Newfoundland.

The area of the valley is 142.6 km^2 (56 sq. miles), as shown in Figure 1. The areas of the Grand Codroy and Little Codroy Estuaries are 9.4 and 3.9 km^2 respectively. Lengths of the estuaries are 4.9 km/3.1 miles) for Little Codroy River and 9.3 km/5.8 miles) for Grand Codroy River (and 7.05 km/4.4 miles to the Bridge).

FIGURE 2: VIEW OF LONG RANGE MOUNTAINS ACROSS GRAND CODROY RIVER , May 9, 2023

FIGURE 3: LITTLE CODROY ESTUARY (Photo taken May 9, 2023)

The People:

One of the first visitors to the Valley was William E. Cormack who spent a few days in the area in 1822 during his epic trek across the Island. He reported finding 5 families in Codroy, 5 families in the area now known as Searston, 2 families along Little Codroy River, and 10 Micmac families living along the Grand Codroy River. He did not mention the presence of Scots or Acadians, so presumably, the non indigenous families were English. One assumes that the earliest settlers, mostly fishermen, would have noticed the fertility of the land and its suitability for farming.

Word of the availability of good fertile land in the Valley, that was free, had reached Cape Breton, where Scottish and Acadian settlers were suffering because land was scarce and unaffordable. These circumstances encouraged Scottish and Acadian farmers to migrate to the Valley to profit from the bounty that beckoned. During the period 1825 to 1845, many Scots, Acadian, and some Irish immigrants arrived in the Codroy Valley making it one of the most diverse communities on the Island. Typically, these immigrants came in family or multi-family groups and settled in close knit villages that fostered use of their original languages. This pattern of settlement helped to preserve the French and Scots Gaelic tongues for over 100 years. In the early years of the 20^{th} century, it was said that four languages could be heard among parishioners walking to church on Sundays - English, French, Scots Gaelic and Micmac.

The early pioneer days must have been difficult, as the work of clearing the heavily forested land for farming, building the first cabins and planting the first crops would have been arduous. Clearly, the first pioneers - men and women, must have been very tough, strong and resilient. The region was very remote and the only access was by sea. Settlers were self reliant: growing their own food, keeping chickens for eggs, cows for milk and butter, sheep for wool, pigs for bacon. Clothing was made of home spun wool. Farmed food was supplemented by country food: game, salmon and berries in season. There was always a surplus of vegetables that were sold to fishing fleets that visited the area every summer. Access improved in 1897 when the Newfoundland Railway reached the Valley. Opening up to the outside world accelerated during World War II when Harmon Air Base (USAF) was constructed in nearby Stephenville. English language education, the advent of English radio and TV also eroded the use of Gaelic and French in the Valley. Nevertheless, use of Gaelic continued in the Valley until the 1960s but only among the elders and as they died the language died with them. French language usage may have followed a similar trajectory. The traditional economy of the Valley: fishing, agriculture and forestry are still active to varying degrees while tourism is a new and growing industry.

The Bridge:

Until 1872 there was no presence of government in the Valley. However, in 1872 residents were authorized to elect 2 representatives to the House of Assembly and from this time onwards government services such as mail, telegraph and a courthouse were gradually established. The construction of roads linking the communities in the Valley was a priority, and were executed under Monseigneur Sear's guidance, mainly by volunteer labour, during the period 1872 to 1885. But there was no road link to the communities on the north side of Grand Codroy River, and access was by ferry in summer and ice roads across the river in winter. Two ferry services operated at various times across Grand Codroy River one at the "Gut" and the other from Upper Ferry, near the head of the Estuary. Except for a single photo of the Gut Ferry, little is known about the ferry operations. I think conditions at Upper Ferry would have been more favourable, as this site is less exposed to wind, the river flow is tranquil and the bottom shallow – circumstances that were suitable to either poled or cable operation. The fact that the community at the ferry site bears the name Upper Ferry suggests it was more important.

FIGURE 4:
“GUT” FERRY

Searston Ferry was operated by Mike Chaisson accross the Grand River at “The Gut” before there was any Bridge accross the River. This picture was taken around 1910.

Roads linking all the principal villages together, built in the period 1872 to 1885, for horse-drawn wheeled carriages, were maintained and upgraded in the following years and would also have been suitable for the first vehicles of the automobile age: rugged Ford Model “T”s of which 6 were owned by Valley residents in 1924!

Starting around 1916 the Newfoundland Highroads Commission initiated a very active program of road and bridge construction. Construction of concrete arch bridges was a new technology replacing less durable timber bridges. In 1923 it was the Valley’s turn for a bridge and quite a bridge it was to be!

The Grand River Bridge (also called the Grand Codroy River Bridge) linked the north shore of Grand Codroy River to the rest of the Valley and the outside world. Sited between Upper Ferry and Great Codroy Village, it was parallel to the old Upper Ferry route. It was 317.60 m (1,042’) long between abutments, and was supported on 8 arches with equal spans of 38.37 m (125.9’), supported on 7 piers and 2 abutments. The width of the roadway between railings was 4.88 m (16’), sufficient for two-way traffic of Ford Model “T”s - width 1.68 m (66”). Building of the bridge started in 1923 with construction of the abutments. The next priority was construction of the seven in-river piers. The engineering plans show that bottom of the piers should be 1.83 m (6’) below the bottom of the river but give no information on how the cofferdams were to be built or about unwatering procedures. I assume that this aspect of the work was the responsibility of the contractor in the field. The only information of pier construction, recorded in 2002, notes that cofferdams were constructed of piles supporting wooden planks that were made water-tight. Planks would likely have been driven vertically as piles and backed by “waler” beams, with over-lapping edges/tongues to ensure water-tightness. This suggests to me what today would be called a “braced cofferdam” design. Once cofferdams were in place the water was bailed out and the river bottom excavated to the required 1.83 m (6’) depth, then concrete was poured to form up the piers. Piers were constructed of unreinforced mass concrete. The shallow water depth 3’ to 6’ (in deeper channels) and tranquil flow would have been favourable to construction.

The final phase was the construction of the arches and roadway. Formwork for concrete arch bridges such as Grand River Bridge was more complex than for contemporary bridge designs that do not usually include curved elements. Typically, formwork for the arches would have been supported on temporary scaffolding of sufficient strength and rigidity to support the weight of formwork, concrete and steel reinforcing, while minimizing deflection from design lines. Although layout work may have required the services of an engineer or surveyor all the complicated formwork was the product of local carpenter/shipbuilders. The skills for such work were most likely learned from the construction of fishing schooners. The quality of workmanship and the beauty of the bridge itself is testimony to the craftsmanship of Newfoundlanders of that time - a century ago. Unfortunately, I have no information on the design of the scaffolding system. Once the arches were poured and the concrete cured, construction of the remaining superstructure would have been straight forward with formwork easily supported from the arches.

Most of the work would have been by manual labour. Particular challenges were:

- Gravel for concrete production was obtained from the island shoals upstream of the bridge site. A scow would have been moved upstream and anchored near the shore line. Gravel would have been loaded by shovel on to the scow and then floated downstream to the bridge site on the falling tide.
- Reinforcing steel delivered by railway to Doyles in lengths of 50’ that were awkward to handle. The solution was to rig up two sets of wagon wheels together in order to navigate the road from Doyles to the bridge site.
- Heavier materials were taken from Doyles to the river near Grand Codroy RV Park and floated downstream by scow, thus short-cutting road travel.
- Small motorized concrete mixers may have been available, otherwise concrete could have been mixed manually.

Work on the bridge started in 1923 with an official blessing from Monseigneur Andrew Sear. On completion of the bridge, he was again called upon to formally open the bridge. On this occasion he tied a small statue of Saint Theresa to the bridge railing invoking her aid to protect bridge users from harm or death.

FIGURE 5: CONSTRUCTION

FIGURE 6: THOMAS ANDREW HALL

This construction of Grand River Bridge would have been a mega project of its time - the 1920s. Its length between abutments of 317.60 m (1044’) remains the longest bridge to date on the Island, not quite as long as the new Churchill River Bridge below Muskrat Falls. I should also mention the CN Viaduct over St. John’s Dockyard, it is 460 m long but its over water length – Waterford River, is minor - only 17 m/56’.

The design engineer was Thomas Andrew Hall (1867 – 1944). He was born in Portadown, Ireland. He studied at the Royal University of Ireland (now Queen's University - Belfast) where he obtained the degrees of B.A. and B.Eng (ca. 1888). He immigrated to Newfoundland in 1906 and served as Government Engineer from 1906 until his retirement in 1944. He was responsible for the design of many bridges for the Newfoundland Highroads Commission, and other public works projects.

William Whelan, of the Government Engineering Department, was responsible for construction supervision. I have practically no information about him, except that he was associated with many of Hall's projects.

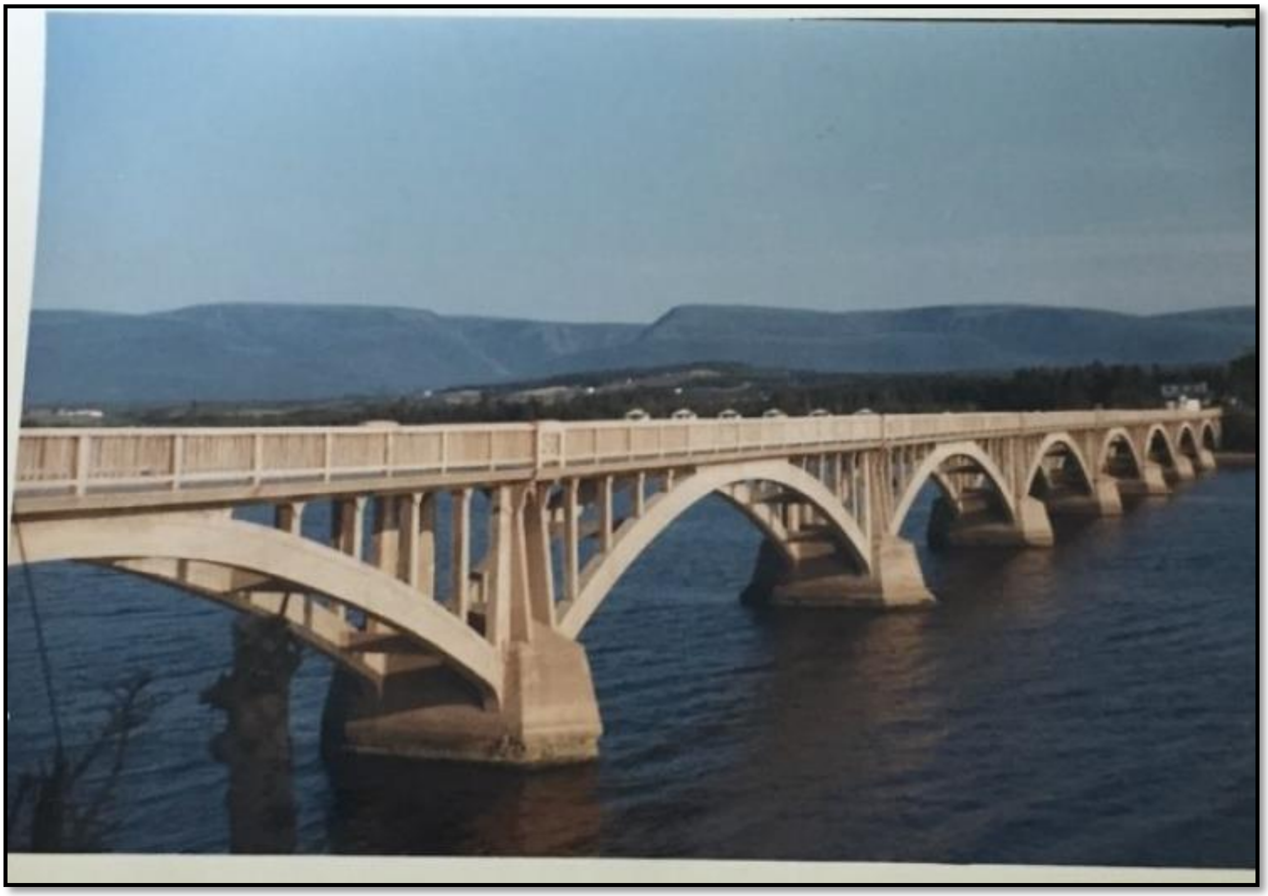


FIGURE 7: GRAND RIVER BRIDGE LOOKING TOWARDS UPPER FERRY IN 1966

Demise:

At about 4:30 pm on January 15, 1978, two teenage girls were returning from basketball practice in the school gym at Upper Ferry. They were part way across the bridge when the bridge started to collapse under their heels. They ran as fast as they could ahead of the collapsing bridge. I dare say they would have set the Newfoundland sprint record for girls, had someone been there with a stop watch to record their run! Thankfully, they reached the north shore safely. Saint Theresa had intervened, just in the nick of time. The collapse started with the scouring of Pier 6, second from the south abutment, which triggered a cascading failure resulting in five of eight spans falling into the river. Only one span on the south end and two on the north end of the bridge remained intact. The collapse happened very quickly - in about half an hour to an hour after the first span fell.

Usually, breakup of the Grand Codroy River Estuary occurs passively by ice melting in place. Exceptionally, in about 1 in 5 years, breakup up is dynamic and produces an ice run as river ice is flushed downstream. This phenomenon is produced when breakup is triggered by the combination of high flows with intact ice covers. A particularly dynamic breakup occurred in January 1978, due to an unseasonable warm spell accompanied by heavy rains, starting on January 14th or thereabouts. This unseasonable rain storm came after an extended period of very cold weather. Based on the degree-days of freezing for the 1977/78 winter to that date, I estimated the ice thickness would have been 0.3 m (1.0’). The resulting flood peak which occurred on January 15 was estimated to have been about 807 m^3/s (28,500 ft^3/s) - equivalent to a 1 in 10-year flood event. Descriptions of previous dynamic breakups noted that ice was usually cleared through a channel near the north bank, this channel was uncharacteristically blocked with ice in 1978 (exceptionally big ice floes observed in the river that year and above average ice strength and thickness may have contributed to this blockage). Meanwhile another channel opened near the south bank diverting much of river flow into this channel. Department of High Roads officials were aware that Pier 6, second pier from the south bank, was vulnerable having suffered significant damage due to scouring over the years. The resulting high flow velocities in the south channel likely aggravated this situation leading to the undermining and destabilization of Pier 6 which led to a domino type failure of the five central spans of the bridge. Ice impact loads may also have been a factor in the initial failure of Pier 6. Figure 8 shows the conditions after collapse of the Bridge.

The Department of Transportation and Communications built a temporary multi-span “Bailey” bridge, at the Gut, to provide access from Searston to Milleville on the north bank of Great Codroy River that was ready for traffic in April 1978. This bridge served until November 2010 when it was closed due to safety concerns.

Meanwhile, a new Grand River Bridge, constructed along the original centre-line was completed in 1983. Its length is 246.6 m/809’ with a 71 m/233’ long causeway from the south Upper Ferry bank of the river (Figure 9).

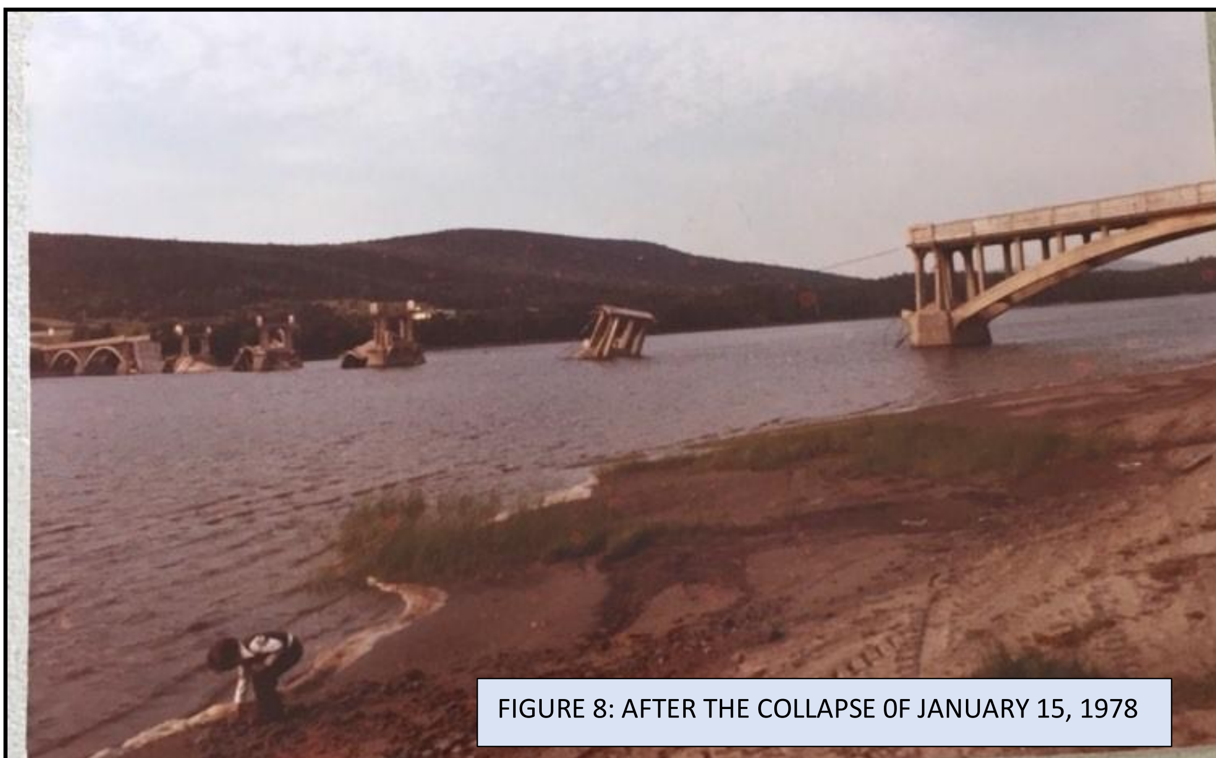


FIGURE 8: AFTER THE COLLAPSE 0F JANUARY 15, 1978

FIGURE 9: NEW GRAND RIVER BRIDGE

FIGURE 10: NEW SEARSTON BRIDGE

After the closure of the temporary bridge at the Gut in November 2010, the Department of Transportation and Communications decided to build a new permanent single lane bridge across the Gut to maintain service to Milleville and beyond (Figure 10). This bridge has two spans with a single mid river pier and is constructed of Mabey panels.

On the centenary of start of construction of the Grand River Bridge (2023), I hope you will join me in celebrating the knowledge and skills of the engineers and skilled workers who created this beautiful and useful bridge.

SOURCES:

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