CLASSIQUES
GARNIER

Carvais (Robert), Lambert (Guy), Ross (Liam), Testori (Olinda), Bondon (Anne), Bruneau (Damien), Langlois (Gilles-Antoine), Hamzeian (Boris), Simonnet (Cyrille), « *Compendia* », *Ædificare Revue internationale d'histoire de la construction*, n° 12, 2022 – 2

DOI : 10.48611/isbn.978-2-406-16730-3.p.0259

The Accident Perspective. A Driver for Construction History

Accidents have always been a feature of the built environment and construction operations over the long term, but they differ widely in causes and extent. While this topic has given rise to a number of practical publications focusing on diagnosis and prevention, it also deserves to be studied from a historical perspective more systematically than has been the case in the past. An accident is spectacular because of its sudden and unexpected nature, and can be defined as the untimely and unfortunate intrusion of hazards that damage or even destroy all or part of a building and/or the operations involved in its construction. It is also characterized by the complexity of its causes, the investigation of which reveals in retrospect the multitude of material and human realities that may have acted as triggers, through the unfortunate combination of external factors and internal vulnerabilities. Following Aristotle, we need to understand that accidents are consubstantial with the technical object, that they are in a sense inevitable. After all, are not the mechanics of the accident already present in the making, in the vicissitudes of practice (hasty decisions, routines that have not been reassessed, lack of maintenance, etc.), sometimes in plain sight? The unpredictability of accidents should therefore be tempered.

Three lines of enquiry are highlighted here. The first concerns the revealing role of the accident. The mass of archives generated by the search for causes and responsibilities tends to shed light on the interrelationships between the actors involved, as well as the workings of the process that usually remain in the shadows of day-to-day practices. The history of construction in the continuity of events differs from the work of experts, which is carried out in the heat of the moment. Since construction is a collective process, both literally and figuratively, it entails a multitude of responsibilities, whose balance it is difficult to assess between the various protagonists and the different levels of reality (where the political, cultural and intellectual compete with the technical and economic). The second area concerns the management, both immediate and delayed, of the consequences of an accident. Organizing rescue services, securing damaged buildings or site installations calls for specific skills, and sometimes know-how or tools from the worlds of architecture and construction. Thirdly, there are the effects on risk prevention and risk culture. Questioning the causes of an accident is often the first step towards putting in place measures designed to prevent future occurrences, such as establishing new building or urban planning rules designed to identify and limit sources of risk.

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On Accident and Invention. Three Episodes in the History of Fire, Safety and Regulation

This article examines the role of accident, invention and regulation in the design of the built environment. Specifically, it considers the way that our tools and practices of building design have been changed by, and have stabilized around, the experience of urban fire and programs of fire-safety.

The article comprises three brief case-studies that recount details of specific urban fires, and the programs of legal, technical and urban reform that followed in their wake. The first case-study is the Great Fire of Meireki, which destroyed Edo and its central castle in 1657. The study shows that post-fire reform took Edo Castle as a paradigm of

urban fire-safety, and details of that building came to shape fire-safety thinking and urban form in the city, in ways that are still visible in contemporary Tokyo, but which have been limited in their effect. The second case-study is the 1877 town fire in Lagos, and the first fire-safety by-law imposed by Nigeria's British colonizers. We consider how this rule, initially used as a means to empower slum clearance, continues to shape contemporary Lagos, sustaining practices of informal settlement and related urban fire-safety risks today. The final study is the September 11, 2001, attacks in New York, and forms of computational analysis for fire-dynamics developed by forensic fire-investigators. It shows that, as employed by designers, these same forms of computational analysis have been deployed to by-pass requirements for compartmentation and structural fire-protection in later high-rise buildings, reproducing characteristics of the World Trade Center fire in future buildings.

Through these three studies, accidents are shown to be moments of "invention;" moments in which we discover unexpected and often undesired characteristics inherent to particular tools and practices. Regulation is here considered as means of coming to terms with that unexpected potential, framing it within tolerable limits. Rather than tending toward universal solutions, the process of standardization and regulation is here described as highly contingent. Shaped by the details of past tragedies, rules and standards give those prior events a spectral presence in new buildings. While seeking to avoid a repetition of past accidents, this process can nonetheless risk trapping the way we think of the future within the problems of the past.

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Limiting and Preventing Fires. The Building Police in the Republic of Geneva (1670–1798)

Fire posed a considerable threat to Ancien Régime cities: wooden buildings, the density of dwellings and piled-up materials increased the risk of urban conflagration. The great fires of London (1666), Rennes (1720), Copenhagen (1728) and Lisbon (1755) attracted attention and mobilized major rescue and prevention measures.

Scholarly works have shown that most cities defended themselves against flames and that "it is against fire that we know best how to fight" (Nières, 1987). According to the judicial archives, the fire police was active from the end of the 17th century. It prevented major conflagrations and, therefore, the destruction of cities. One major way to reduce the risks was to act on the specific question of building. Thus, this article focuses on the preventive measures integrated into the building regulation in Geneva between 1670 and 1798.

As a sovereign republic and fortified city throughout the Ancien Régime, Geneva occupied a central and strategic position in the heart of absolutist Europe. On the night of the of January 17, 1670, the wooden bridge over the Rhône caught fire. The houses on both banks, inhabited by two hundred families, were burned to ash. The consequences were catastrophic: one hundred and twenty-one people died and eight hundred were left homeless. After this event, the authorities quickly and massively invested in the fight against fire. Prevention fell partly under the responsibility of the building police. From the end of the 17th century, the magistrates took care to regulate construction (wall thicknesses, length of eaves, spacing of houses). Special attention was given to the solidity of buildings and control of the use of flammable materials. The legislation adopted and renewed several times led to greater vigilance and contributed to the reduction of large-scale fires. From 1770 onwards, the professional activities necessitating fire required new ways of dealing with risk. For example, the workshops of metal founders, set up within the domestic space in the middle of the city, required special attention as they posed a serious threat to their surroundings. The role of experts, which had been growing since 1750, was decisive in the process of identifying the individuals responsible for the outbreak of fires that occurred in the workplace.

On the basis of fifty-three legal proceedings initiated to look into a fire, police regulations and the minutes of council meetings, this research highlights the prevention policy involving regulation of the built environment.

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The Fall of the Promenade Wall or the Vicissitudes of a Laval Construction Site. Skills, References and Responsibilities of an *Architecte Voyer* (1844–1848)

There is nothing spectacular about the accident described in this article. It involves the collapse of part of an earthfill-retaining wall on the promenade of the Place de l'Hôtel de Ville in Laval, the prefecture of the Mayenne department, France. The fall of the wall, which was only 4 meters high, did not cause any casualties. However, it collapsed twice, in 1844 and again in 1846. The local council, which commissioned the work, considered this intolerable. While they agreed to blame the heavy rains of September 1844 for the first accident, they thought the second one resulted from blatant incompetence. Pierre Aimé Renous, the Laval *architecte voyer*, and Ambroise Corbin, the masonry contractor, had to explain themselves. This event, however modest, was taken very seriously: experts were appointed; letters were exchanged; reports were issued; and the press covered it.

Since, in this affair, everyone had to justify the least of their actions, it gives historians access to a large amount of archival material to understand how the construction work was carried out and the way the courts were supposed to deal with it in a provincial town under the July Monarchy (1830–1848). It also provides a detailed insight into the work of a self-taught architect and his relationships with the various parties involved. Finally, it offers the opportunity to explore two issues: the references used by the different actors in the various projects to rebuild the wall, and, more centrally, responsibility.

The mayor and his councilors called for shared responsibilities, but argued that Renous, as project leader, must take responsibility for the mason's faults. The experts, for their part, held the architect solely responsible but could not order him to pay for the damage since Renous, actually an *architecte voyer*, did not receive any fees for his work. Finally, the architect blamed the heavy rains that fell on the town and maintained that his calculations were correct – and if not, that he could not be held responsible because of his status. Although the design of the wall seemed to be the main issue in this conflict, it was the role of the architect, which was still largely unregulated at the time, that ultimately proved decisive.

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The Problematic Survival of Fragile Coastal Buildings (United Kingdom, 19th-21st Centuries)

English engineer Eugenius Birch (1818-1884) designed nearly 14 piers in the United Kingdom from 1855 to 1884. Like the 86 piers of this type that covered the British coast in 1914, they usually consisted of a wooden pontoon on a metal structure that advanced from the coast out to sea. These 14 pleasure piers benefited from the English engineer's innovations such as the use of screw piles and iron foundations. He managed to adapt to various seabeds, whether sandy (Margate, Blackpool, etc.), clay (Hastings, etc.) or chalk (Brighton, etc.). The physical relationship of these piers to the sea might be unstable and require solid foundations: storms, coastal floods, wood-eating marine shellfish and collisions with ships damaged or destroyed many of these buildings, typical of the architecture of British seaside resorts. On several occasions, Birch designed piers that were too low for the strength of the waves; the subsequent upgrades were costly and sometimes too late. Beyond their original design, Eugenius Birch's piers have variously faced the wear and tear of time and bad weather. In addition, most of them were put at risk by, at least, one fire: the lack of maintenance, renovation and monitoring of these largely wooden structures is one of the causes. Although these fires were often superficial and the buildings, originally made of wood, burned very frequently, storms and collisions still damaged the overall structure, sometimes irremediably. From the 1920s onwards, efforts were made to fire-proof wood by impregnation to limit the occurrence of spontaneous combustion, as well as the use of fire-resistant paints. In addition, firefighters were generally closely associated with the piers, both at the opening ceremonies and through the frequent installation of marine life stations in direct proximity. After the Second World War, the generalization of concrete did not revolutionize the fate of the piers. The heaviness of this material makes it less suitable for the construction of buildings installed on the piers, which required designing lighter structures or reinforcing the pillars. After more than a century and a half of existence and many evolutions, five of these 14 piers are still open to the public in Blackpool, Aberystwyth, Bournemouth, Eastbourne and Hastings.

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Malpasset 1959 – The One We Feared. Technological, Organizational and Ecological History of an Anthropogenic Disaster

This article traces the facts, causes and consequences of the failure of the Malpasset dam, built on the Reyran river in the Var department, France, and designed by engineer André Coyne. Beyond the facts, the study of the disaster, from a geological, technological, organizational and ecological point of view, illustrates the fragility of preliminary studies and decision-making chains, as well as the long-term environmental impact. It also highlights, given the recent collapse of the Derna dams in Libya, the complexity of managing such infrastructure nowadays.

The Malpasset dam, a major element in post-war reconstruction, had to fulfill a triple function of managing the waters of the Reyran, and supplying water for agriculture and towns. For economy and simplicity, it was decided to build a single dam rather than several small reservoirs.

Extensive geological studies had been carried out to determine the exact site of the dam. Its typology was modern for the time, but not revolutionary: a concrete dam with a thin arch, resting on two stable gneiss slopes.

The construction was made more complex by the choice to move the construction site slightly, difficult negotiations with the few manufacturers active in the sector, the lack of supervision of the mandated companies and far too late commissioning of the phototopographical data.

The filling of the reservoir took place very slowly from 1954 to 1958, and the final acceptance of the dam did not take place until 1957. During November 1959, heavy rains caused the Reyran to flood and very quickly, the filling level was reached, then exceeded.

It was then that the structure suddenly gave way, a huge wave crashing into the valley, onto the Autoroute du Soleil construction site and the town of Fréjus, some 13 kilometers away. There were 423 deaths. This was the first time that a dam by André Coyne, who built hundreds of them, was destroyed in this way. The astonishment it caused, given the engineer's fame, considerably advanced studies of all kinds and caused a complete overhaul of rules by the International Commission on Large Dams.

This summary article studies the consequences of the disaster from the perspective of the history of geology and soil mechanics, and organizational theories and concludes with an ecological study of the site 60 years after the disaster. The research aims to study, in the Anthropocene context, the capacity for resilience and creation of *societalities* of human communities, which will always need water.

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The Challenge of Manufacturing Cast Steel for the Nodes and the "Gerberettes" at the Centre Pompidou. From Failure to Rescue

The steel structure of the Centre du plateau Beaubourg, today known as Centre national d'art et de culture Georges Pompidou, the result of a collaboration between the engineering firm Ove Arup & Partners and Piano+Rogers Architects, represents one of the most challenging and avant-garde works of the second half of the 20th century. With its articulations of sculptural and curvilinear lines, this work recovered the special technique of metal casting from the tradition of the great roofs of the 19th century, renewing it through the experimental use of steel. The achievement of this result, however, required an unprecedented engineering design that did not limit the use of cast steel to individual joints but extended it to cantilevered beams subjected to significant stresses of compression and bending, challenging the usual use of cast metal in construction.

Against a backdrop of hesitation by the entire consortium of French companies, only the German steelworks Krupp Industrie und Stahlbau and the Pohlig Heinz Bleichert foundries accepted the challenge set by Ove Arup & Partners engineers Peter Rice and Lennart Grut. In order to complete this work, the German companies took on risky and even daring challenges. The fabrication of the work became the scene of a series of multiple accidents and worrying episodes that included the deliberate alteration of the specifications for the composition of the casting steel and its manufacture indicated in the contract, the appearance of major defects and cracks on hundreds of pieces, a complex and problematic inspection and control procedure, the breaking of some moldings between the fabrication and assembly stages, and even a complex salvage procedure that required the attention of the greatest German and European metallurgy experts.

From these dramatic manufacturing accidents and by analyzing the documentation and the testimonies of architects, engineers and company directors involved in the construction site, this essay aims to construct the first integral chronological history of the problematic fabrication of the cast steel of the Centre Pompidou. The clarification of the reasons, consequences and remedies surrounding the accidental fabrication and breaking of the cast steel may become a useful tool for the renovation and restoration work on the Centre from 2025 to 2030.

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The Great Collapse. Genoa, 14 August 2018. Open Appraisals From a Specialist in Construction Culture

The collapse of the bridge over the Polcevera, known as the Ponte Morandi, in the summer of 2018 caused worldwide alarm. Designed in 1959 and completed in 1967, this Genoa viaduct was one of the major works of the engineer Riccardo Morandi (1902-1989). In the context of the production of large motorway structures at the time of the Italian "economic miracle," the bridge is examined from the dual perspective of its use ("serving") and its construction ("holding"). At the junction of these two categories, the bridge and the road merged in their "physicality," which was established in the techno-administrative system that made the road (in this case, the highway) a major component in the economic development of the entire country.

The spectacular scale of the viaduct's collapse was commensurate with the monumentality of the structure. The media impact of the event led to a number of diagnostic pronouncements, most of which blamed the engineer's construction system (which, incidentally, he was the only one to use). The analysis of the disaster is nevertheless enriched by historical considerations linked to the economic and productive context of engineering in Italy in the 1960s. The technical question is placed in this context. Analysis is also informed by a relative understanding of the processes then in use. The cable-stayed bridge, for example, only really came into its own at the end of the 1970s.

While the construction system may have been questioned, particularly the principle of prestressed straps, the principle of monitoring and maintenance has also been criticized.

During the almost sixty years of its operation, the viaduct saw an increasing growth in traffic, leading to a certain degradation of its structures. Its maintenance, which was privatized in 1999, did not follow this trend. The phenomenon of its collapse is considered at the intersection of service and maintenance, calling for a comprehensive rethinking of the production of such structures in the light of notions such as risk and catastrophe.

The causes of the destruction, always uncertain, are approached with respect to mechanical notions (rupture, fracture), factors of wear (degradation, damage), and in the long term, hydrogeological factors (scouring).

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