

Entry

COVID-19 in the Construction Sector

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Definition: This section analyzes the influence of COVID-19 in the construction sector. Construction workers' high vulnerability to the spread of the virus motivated this entry. The construction sector's peculiarities and some work procedure characteristics in this sector make telecommuting impossible in most activities. In addition, most of the states and national governments declared the construction sector essential activity due to its high economic impact. The working conditions in this sector are very special: constant trips to work in groups, work group execution with little interpersonal distance, group travel, stays and accommodations away from home, meals in restaurants or work canteens, lunch in restaurants or work canteens, etc. Due to all of this, the contagion rate was very high during the pandemic months. Even today, it is still considered one of the most dangerous sectors for these purposes. With all this in mind, here we discuss why it is difficult to minimize the spread of the virus for construction workers, summarize how to assess exposure risk grades for construction job tasks, and provide possible protection requirements for the different exposure risk grades.

Keywords: COVID-19; construction sector; building work; civil work



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1. Introduction

The year 2020 changed humanity. In March 2020, a global pandemic was declared due to the new coronavirus SARS-CoV-2. This virus produces the disease known as COVID-19 [1]. Since the pandemic's declaration, the virus has kept the entire world on edge, with borders closed for many months and millions of citizens confined at home.

COVID-19 infections have proliferated very quickly around the world. During the first few months, governments made extraordinary decisions to limit the virus spread and prevent health systems collapsing.

Two years later, scientists still have some confusion about the virus's mechanism operation and its effect on the human body. However, everybody knows this virus is highly contagious and its effects can be very harmful and even deadly.

The construction sector's activity includes all types of building (residential and non-residential) construction, rehabilitation, maintenance, and demolition. It includes civil engineering works also, such as roads, railways, or pipeline transport execution, all their complementary works (such as bridges or tunnels), and the rest of public service system execution [2].

Several market groups are involved in the construction sector, such as architectural and engineering design, materials and equipment production, transportation, or energy and waste management, to name just a few. Construction creates value thanks to the transformation of basic raw materials into capital goods, which are essential for economic activity and the provision of infrastructure services [2]. Its labor and economic importance is unquestionable.

Therefore, the Occupational Safety and Health Administration (an agency from the United States Department of Labor) includes within the sector, in addition to employers and construction workers, those engaged in carpentry, ironworking, plumbing, electrical, heating, ventilation, air conditioning, masonry and concrete work, utility construction work, and earthmoving activities [3].

Construction sector activity can have a great impact on generating economic income and reducing poverty. Its potential to create employment is considerable due to its labor-intensive nature and its links with many other economic sectors as well.

Before the pandemic, the construction sector represented about 7.7% of global employment [4]. Forecasts for 2020 were that construction would contribute 13.4% of the global GDP, but the COVID-19 crisis changed everything [5].

2. Industrial Hygiene and Construction

Industrial hygiene is a preventive technique. There are very varied definitions for industrial hygiene. Almost all of them have essentially the same orientation and meaning: it tries to prevent occupational diseases [6]. To achieve this, industrial hygiene acts on the risk factors of a physical, chemical, or biological nature, measuring and assessing the contaminants present in the work to eliminate them or, if this is not possible, to reduce them [7].

Therefore, industrial hygiene is the occupational risk prevention technique responsible for identifying, evaluating, and controlling hygienic risks originating in the workplace which can endanger the workers' health through the work environment. It can also be considered a non-medical technique for occupational diseases prevention by controlling the contaminants that cause these diseases in work environment.

Therefore, there is a clear and primary objective: to protect and promote workers' health and well-being and the environment in general through the preventive measures in workplace series adoption.

An important part of labor production processes is producing changes in the work environment. These modifications provoke a series of aggressive agents for the health of the workers. These harmful agents are pollutants or contaminants.

A pollutant or contaminant is a substance, a form of energy, or a living being (or a part of a living being) present in the work environment which, at a sufficient concentration, can get into the environment. It can pass from the environment to the human body, causing negative or harmful effects to the health of a worker. Thus, it gives rise to hygienic risk: the probability of suffering alterations to one's health due to the action of contaminants present in the environment during the performance of a certain job.

According to current legislation, environmental condition exposure in the workplace cannot put workers' safety and health at risk. Therefore, a company must adopt adequate preventive and control measures in the presence of every contaminant.

Safety at work is the most attended preventive technique in the construction sector. However, industrial hygiene is also very important. Construction sector workers are exposed to risks associated with contaminating agents in their workplaces daily, including noise, mechanical vibrations, solar radiation (workers outdoors), or dangerous substances such as chemicals, crystalline silica dust, or even asbestos, one of the most dangerous substances still present in old buildings.

The SARS-CoV-2 coronavirus is a virus. Consequently, it is a biological contaminant. Biological contaminants are organisms with a certain life cycle which cause, when entering the human body, a negative effect on one's health, which is different in each case (always depending on the causal agent). This life cycle includes the reproduction and growth processes [8]. Therefore, biological contaminants can be, in addition to viruses, bacteria, fungi, or parasites, for example.

In general, the construction sector does not include activities where biological risk is an occupational risk [9]. Under normal conditions (before the pandemic), contagions among construction workers could only occur exceptionally.

It differentiates construction from other activities, such as social and health activities [10]. In them, COVID-19 contagion is considered an occupational health issue. However, the virus's incidence in the construction sector has been considered a public health issue [11] from the beginning. Contagion risk is not related to the work execution processes.

3. COVID-19 Risk Assessment Construction

The intervention of the company in all occupational risk management is crucial. The company must support its occupational risk prevention service because it is key to this.

Although it is not an occupational hazard, but it is a matter of public health, the risk of contagion from coronavirus is not an exception. Despite the vaccines, companies' actions against exposure to SARS-COV-2 were crucial, are crucial, and will continue being crucial. Companies have had to adapt their activities with recommendations and updated prevention measures to avoid possible contagion. These measures were (ranked in order):

1. Organizational measures;
2. Collective protection measures;
3. Individual or personal protection measures;
4. Special measures for especially vulnerable workers.

All the above measures must always be in accordance with the level of risk. In addition, the company has to study all cases of contagion and contact that have occurred in the company. The company also has to collaborate to manage temporary disabilities.

Legislation and states have required the cooperation of companies with health authorities in every way to detect all cases compatible with COVID-19 and their contacts as soon as possible. Only then is transmission controlled.

Companies have to assess the risk of exposure to which workers may be exposed in each of the differentiated tasks they perform. Companies must follow the recommendations issued by the prevention service regarding the risk of exposure and protection against it. Prevention services have to recommend following the guidelines and recommendations given by health authorities.

Construction companies have not been an exception. Construction companies have had to comply with the regulations and recommendations and try to protect their workers just like the rest of the companies, despite the difficulties imposed by the sector.

Any decision making on the preventive measures to be adopted in each company must be based on information collected through the specific exposure risk assessment, which will always be carried out in accordance with the information provided by the health authorities.

Depending on the nature of the activities and the transmission mechanisms of the SARS-CoV-2 coronavirus, we can establish the different exposure scenarios in which workers can be found, which are presented in the following table, in order to establish the required preventive measures.

Below are the classification criteria followed by the Spanish Ministry of Health [12], which distinguishes the following types of exposure:

1. Risk exposure: A work situation where close contact with a case of coronavirus infection (or suspected infection) may occur;
2. Low exposure risk: A work situation where the worker may be related to a suspected or confirmed case without being in close contact;
3. Low exposure probability: Workers without direct attention to the public or workers who, if they attend directly to the public, do it at more than 2 meters of distance or have collective protection elements that serve as a barrier which prevent possible contacts (such as, for example, a glass partition).

To break down these categories, the Ministry prepared Table 1.

According to Table 1, construction site personnel belong to the risk exposure category. A construction site, whether civil work or building work, is a situation in which close contact with a possible case of a worker infected with COVID-19 cannot be avoided.

Table 1. Exposure risk degrees to SARS-CoV-2 coronavirus in the work environment [12].

Exposure Risk	Low Exposure Risk	Low Exposure Probability
Health care personnel and non-care personnel who care for COVID-19 suspected cases or COVID-19 confirmed cases. Medical transport technicians, who can transfer and contact directly COVID-19 suspected cases or COVID-19 confirmed cases. It is impossible to avoid close contact with a COVID-19 suspected case or a COVID-19 confirmed case at work.	Health professionals without close contact with a suspected case of COVID-19 or a confirmed case of COVID-19 in their work activity. This is the case of, for example, transfer companions, guards, stretcher bearers, or hospital cleaning staff. Laboratory personnel responsible for virological diagnostic tests. Non-health professionals who come into contact with possibly contaminated medical material, fomites, or waste. Home help for asymptomatic contacts.	Workers without direct attention to the public, from more than 2 m away, or with collective protection measures to avoid contact.

Another example more applied to the case was given by the Occupational Safety and Health Administration [3] agency from the United States Department of Labor. To evaluate the exposure risk, OSHA developed Table 2, which describes construction work tasks associated with the exposure risk levels.

Table 2. Construction work tasks associated with exposure risk levels [3].

Lower (Caution)	Medium	High	Very High
Tasks that allow employees to remain at least 1.85 m apart and involve little contact with the public, visitors, or customers.	Tasks that require workers to be within 1.85 m of one another. Tasks that require workers to be in close contact (within 1.85 m) with customers, visitors, or members of the public.	Entering an in-door work site occupied by people such as other workers, customers, or residents suspected of having or known to have COVID-19, including when an occupant of the site reports signs and symptoms consistent with COVID-19. Note: Employers may consider delaying this work by following the guidance below.	Category not applicable for most anticipated work tasks.

In civil works, it is usual to work outdoors, supposing a ventilated environment and synonymous security. The same happens in the initial phases of construction work for buildings (e.g., soil movements and excavations or execution of foundations and structures). It is important that before the coronavirus pandemic, studies already showed that 52% of indoor air pollution is due to inadequate ventilation. In contrast, 5% is due to microbial contamination, and 3% is due to building constituent materials [13].

Apart from this, in each work environment, it is necessary to analyze the existing risk for each trade present and for each task to be carried out, always depending on the environment where the work is carried out. Despite this, it is very difficult to control exposure risk, as it depends on every worker’s attitude. In construction sites, getting

workers to wear a mask permanently and adopt distancing measures is a daily battle, especially in hot areas or in summertime. The following photographs (Figures 1–5) show examples of construction activities, in civil work and building work, where the safety distance was not respected and workers did not always wear mask protection.



Figure 1. Workers finishing hydraulic pump placement in civil work for water conduction. The work had to be performed in pairs without a safe distance (author's photograph).



Figure 2. Workers spreading concrete on an open-air screed without keeping safety distance (author's photograph).



Figure 3. Workers exchanging a protection element in an elevator shaft in a building's interior rehabilitation work. The photograph indicates the separation distance between workers (author's photograph).

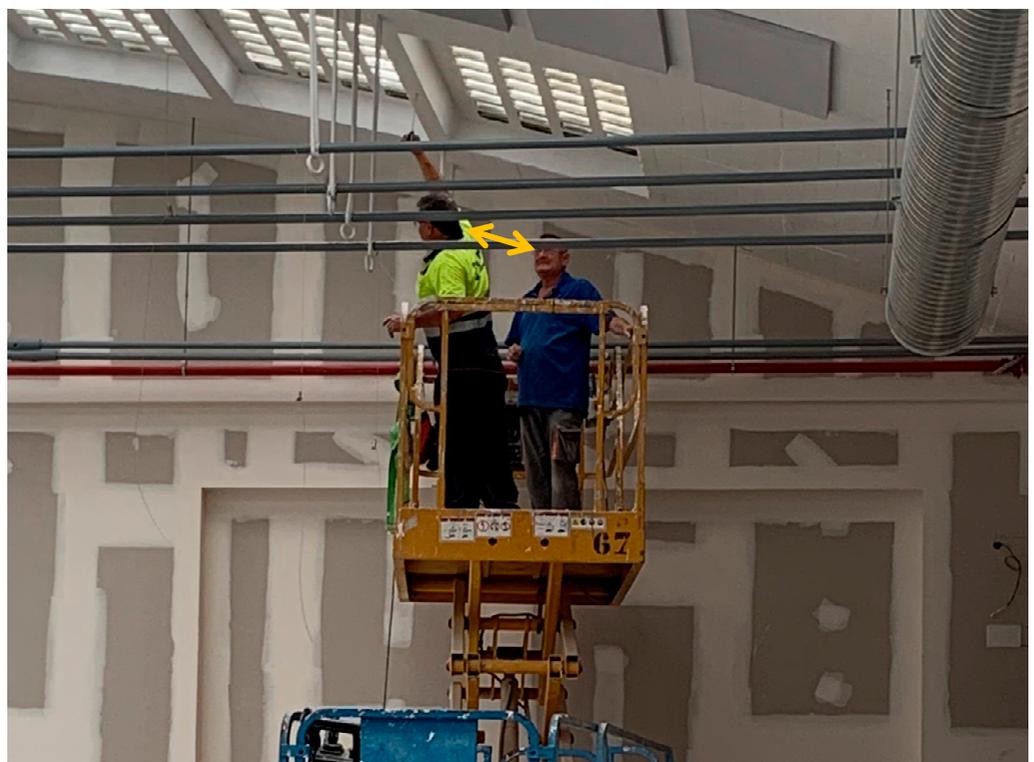


Figure 4. Workers installing false ceiling supports on a lifting platform. The photograph marks the distance between the workers, which is lower than 1.00 m (author's photograph).



Figure 5. Workers having lunch outside the dining booth and not keeping a safe distance (author's photograph).

In this sector, many activities cannot be carried out alone; many activities need work teams, where there is a lot of proximity between workers.

This is aggravated by the usual practices of many workers in the sector. A lot of workers have lunch and dinner together in bars and restaurants or in work canteens (closed environments). A lot of workers go to a bar at the end of the day to drink in a group. A lot of workers stay in rooms or shared housing on weekdays. A lot of workers go to work on public transport or travel as a group in a common vehicle. All of this is common in the sector. Companies cannot control this, as doing so is impossible [14].

Indeed, most infections have not occurred on construction sites but on public transport or in shared vehicles, as well as in the case of posted workers in shared flats and, above all, in the personal environment of the worker [15].

Although most infections have not occurred on construction sites [16], an infected worker at a site is a potential risk, especially for building construction work. It is very difficult to control this, and it was even more difficult even in previous months when there was a testing deficit.

Added to this is the importance of the figure of the asymptomatic patient, one of the greatest difficulties of this pandemic [17].

4. COVID-19 Protection and Prevention in Construction

As we said before, companies have to assess the risk of exposure for all their workers. Thus, they will be able to fulfill their obligation to guarantee effective protection for the safety and health of their workers.

In the particular case of the coronavirus, companies must follow health authorities' guidelines and recommendations [1,3,12,14].

Common recommendations include the following:

- Hand hygiene: This is the main measure for COVID-19 infection prevention and control. From the beginning, the importance of personal hygiene measures was highlighted. It was essential to reinforce personal hygiene measures in all areas of

- work and in any exposure scenario. For this, companies had to provide all the means necessary for workers to clean themselves properly.
- Respiratory protection. This includes the following:
 - a. Respiratory protection mask use.
 - b. Covering the nose and mouth when coughing or sneezing. During 2020, masks were in short supply. People had to look for alternative solutions, and one of them was covering with a handkerchief, which was disposed of afterward in the garbage (always with a lid and pedal). When handkerchiefs were not available, people used the insides of their elbows for this, and thus their hands were not contaminated.
 - c. Not touching the eyes, nose, or mouth.
 - Respiratory hygiene habits: Society has become aware of the importance of ventilation in recent months. In this sense, building work is more dangerous than civil work generally. For this reason, construction works carried out in a closed area require regular ventilation.
 - Maintenance physical separation distance: Various studies have given rise to the distance fluctuating in its value. Right here, we have seen how the Spanish authorities established 1.50 m and the American authorities raised it to 1.85 m (6 feet).

According to the different types of exposure, the Spanish Ministry of Health established the protection requirements [12] listed in Table 3.

Table 3. Requirements for exposure risk degrees to SARS-CoV-2 in the work environment [12].

Exposure Risk	Low Exposure Risk	Low Exposure Probability
Personal protective equipment components for biological protection and for aerosol and splash protection under certain circumstances. It depends on the specific exposure risk evaluation in each case.	Personal protective equipment components for biological protection. It depends on the specific exposure risk evaluation in each case.	Personal protective equipment use is not necessary. In special circumstances, respiratory protection or protective gloves may be necessary. Do not forget that collective protection reduces risk, and personal protection only reduces damage.

As we have seen in previous subsections, it is advisable to use mobility options that best guarantee an interpersonal distance of at least 1.50 m whenever possible.

One of the characteristics of construction work is the intervention of numerous figures in the management of people's occupational health and safety. Coordination and cooperation between all figures is relevant, with each one from the role that corresponds to playing, promoting, assessing, agreeing, planning, implementing, and controlling the extraordinary measures that are necessary to avoid contagion by SARS-CoV-2 [14].

These measures probably affect the technical and organizational conditions of the work and the execution times and costs of the work. However, it is essential to accept these extraordinary changes as well as integrate the recommendations and instructions issued by the health authorities at all times in order to stop the pandemic and reduce the number of those affected.

When de-escalation started, to return to work after the worst months of the pandemic, all these measures had to be taken into account [18].

5. Impact of COVID-19 on the Construction Sector

The construction sector reaches beyond construction sites. There are many sectors and areas that directly or indirectly depend on it. Everything covered by the construction sector has already been mentioned in Section 1 [2].

The risk of contagion on a construction site is really high, as we saw in Section 3. A worker's illness and, above all, a worker's death are preventable misfortunes, and these are occupational health and safety failures.

Protection of the health of workers (and non-workers as well) has been a maxim throughout the pandemic. This meant paralyzing a very important part of world's economic activity. Despite being declared an essential activity, this stoppage affected the construction sector in a lot of countries [19]. There are many trades involved in a construction site from the project phase to the completion of execution of the work. All of them have been affected by the pandemic in one way or another [20]. This is explained by the economic importance of the construction sector. For example, 11.2 million people work in the construction sector in the USA [21]. Latin American countries invest an average of 28% of their total average spending in public transport infrastructure, which includes land transport, rail transport, and air transport, among others. These same countries invest an average of 19.7% of spending in housing construction and the construction of community services, such as public water supply networks and public electricity supply networks [22].

On an economic level, the problem has gone beyond the construction site; it has affected supply chains and transport, caused labor shortages and unemployment, caused problems of contractual implication, and of course, it has brought financial problems [18]. Investment in construction has a multiplying effect on the economy, generating indirect employment and boosting other industries that are part of the production chain. Likewise, this sector employs a high proportion of the unskilled and socioeconomically vulnerable population that depends on daily income, affecting populations that do not have an "economic cushion" that allows them to support themselves for a long time [2].

For the protection and prevention measures of COVID-19 at construction sites analyzed in Section 4, which include compliance with the guidelines of the WHO and the corresponding government, maintenance of social distance, and the use of protective equipment [18], it was necessary to add other structural measures. These measures could be grouped into two groups able, at this point, to assess the effectiveness of several of them, which have been adopted:

1. Technical, logistical, and organizational measures to be adopted by companies with public administration help: Here would be the increase in remote work (something difficult in a sector where few workers can telecommute), the use of 3D printing, and modular or prefabricated construction [19], in which certain elements of construction are manufactured in an industrial plant, where procedures are more controlled and hygiene and social distance measures can be better applied. It has already been pointed out that construction activities were considered essential activities in a lot of countries, so they continued operating throughout the pandemic months. In fact, the construction sector is essential for the economy. Therefore, this sector is key to the economic recovery of a lot of countries. The security measures and protocols to reduce the spread of COVID-19, which began at every construction site, are very important to ensure that reactivation [18].
2. Fiscal and financial measures encouraged by public administrations: Some countries have adopted fiscal and financial measures for the construction sector. With them, the states tried to reduce the negative impact on employment and avoid the bankruptcy of more companies in the sector. There are several interesting experiences in this regard. The experiences of some countries serve as an example:
 - a. Belgium, where companies in the sector came to temporarily close in the hardest months of the pandemic. Due to this situation, the National Unemployment Office paid up to 70% of the workers' salaries [23,24].
 - b. Canada, which offered a colossal amount of money (CAD 65 billion) for business credit financing in certain sectors, notably construction [25].
 - c. Argentina, which subsidized loans from companies related to construction [26].
 - d. Israel, which increased by 2% the percentage of the credit portfolios of banks that financed companies in the construction sector [27,28].

6. Conclusions

- The coronavirus pandemic has caused illness, death, and economic hardship around the world. In addition to the threat to public health, social and economic shocks endanger the livelihoods and well-being of millions of workers, including those in the construction industry.
- In general, the construction sector does not include activities where biological risk is an occupational hazard because contagion from construction workers could only occur exceptionally. However, the virus affects everyone, both workers and non-workers, and every worker can carry it to work. Minimizing the spread of the virus was and remains a top priority. It can be particularly difficult for construction workers, as most of them are unable to telecommute and often work in close proximity to each other in an ever-changing work environment.
- This paper sections described that, depending on the nature of the activities and SARS-CoV-2 coronavirus transmission mechanisms, the different risk scenarios in which the workers can be found can be established. The stated criteria define three scenarios: risk, low risk, and low exposure probability, with a table that provides examples of working personnel or situations that meet the definitions to be located in each risk scenario. Afterward, a new table established the requirements to determine the measures to be adopted in each specific situation. These are, as the document clearly indicates, examples of activities or work situations and not an exhaustive list of them. Workers cannot be placed in any of the three defined scenarios permanently and generally but always depending on the nature of the activities and the exposure risk assessment. The preventive measures to be adopted in each case will be determined based on the specific evaluation of the risk of exposure. This evaluation is the only technical activity that can serve as a basis for making preventive technical decisions adapted to each case.
- The evaluation criteria have shown that full construction worker protection is very difficult (if not impossible). Within the risk scenarios for exposure to coronavirus, construction workers and the nature of the work they carry out (in the absence of collective protection) are in a situation of risk exposure. This risk is higher or lower depending on the type of work and the type of construction work. Open-air civil work is not the same as an interior reform in a building. For this reason, within the tasks associated with the levels of exposure risk, a distinction is made between a low level, medium level, high level, or very high level of risk. However, none of these contemplate null risk or nonexistent risk. Furthermore, the low level included the caution in parentheses. In addition, these evaluations have also served to demonstrate cleaning measures' importance and work organization and distribution measures' importance, especially with regard to travel, access to the work site for staff, and the operator's location in the workplace to maintain a safe distance.
- The measures of social distancing, cleaning, and disinfection within the workplace require pedagogy, where easy-to-understand guides and training courses for workers are necessary.
- The measures within the work must be complemented with measures that promote safety in transport, with the performance of risk analysis at the construction sites and consensus on the measures among the intervening agents (companies, clients or public administration, and workers).
- Fiscal and financial measures were and are necessary to reactivate the construction sector. All public measures must be adapted to the context of each country. Many of these measures are proving to be effective in the short term and may help companies and projects that were underway before the pandemic to survive. However, after 2 years of the pandemic, it is necessary to think about reforms in the construction sector in the long term. It should not be forgotten that only a few workers in the sector can telecommute. For that, and also thanks to that, the pandemic showed that the

digitization of many services was possible. There was a notable deficit in this area, and there is still much to be done.

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