

Construction Site Visits During Pandemic Period and Their Use in Post-Pandemic Times

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Abstract

During the years 2020 - 2021, students and lecturers have faced academical challenges like no other generation before them. One of the most important changes was the inability of attending construction sites due to the pandemic conditions. Using different communication technologies, we developed a virtual lab on construction site visits to keep the students updated in everything related to the direct application of structural design concepts. After the pandemic restrictions were released, we have been using the experience obtained by keeping these virtual labs working. Sometimes, the construction site offers a limited attendance capacity so many students are not invited to be at the site, sometimes students are not close enough to the construction site, and other times, health or economic restrictions does not allow them to be at the site visit. This virtual construction site visit lab allows everybody interested to be an active participant of these activities.

The objective of this paper is to evaluate the benefits obtained for the structural design learning process of these virtual construction sites lab. Construction site visits has always been a highly valuable element of Civil Engineering programs. It allows students to visualize construction processes and translate the numerical activities studied in the classroom to tangible projects. With the pandemic and the stay-at-home guidelines, construction site visits have a positive distraction factor from reality, becoming an element that motivates the students to participate and divert themselves from the current situation, additionally to the academical benefits that the visits provide.

The purpose of this study is to present the results obtained by giving the students the opportunity of having an interactive, live-broadcast, virtual construction site visit without the necessity of actually being in the site. The purpose of the implementation of live streaming tools is to eliminate the one-way-talk, with the professor only speaking to himself. There must be real-time interaction with the students in order to fulfill the emotional necessity of the student to feel as an active part of the activity, as well as granting him the advantages of making all of his questions in the moment they are presented and not later on, when both, the curiosity or the complete information, may be gone. The capability of students to attend construction sites in contingency situations, is fundamental for the completion of the academic goals of the Civil Engineering curricula. It's important that the students recognize this and the importance of the opportunity of experiencing these activities in challenging times.

Keywords: Site visits, structural engineering, virtual labs, Tec21, Higher Education

1 Introduction

In March 2020, the initial period of world's pandemic period, affected almost every human activity around the globe. House living, every job, family activities, and education among many others. Civil engineering students and professors were affected by not being in the same classroom simultaneously like almost every over major but one of the main activities suspended by these events were the construction site visits (CSV).

Through many years, the theoretical and numerical study of the structural behavior of buildings have been complemented by the construction site visits, which give the students a wider view and enhance the comprehension of structural concepts and behavior with more precision and enlightenment, what is shown inside the classrooms with pictures, diagrams,

blueprints and drawings. The fact that the students can see and feel a structural element and be able to be there, when it's been prepared, rebar, pouring concrete and being build in general, widens the perspective from where they can see the structural concept and behavior of elements. There are not only numbers, equations, codes and guidelines anymore, they become concrete and steel elements that have a meaning in the structure and define the structural behavior. There are no longer 2D drawings or 3D renders, they are real structures with dimensions, volume, shape and meaning in a complete structure. In some cases, the construction site administrators, with high personal security concerns, allow the students to perform some basic activities in the site, such as bending steel bars, distributing and tying stirrups in a beam rebaring, or supervising the taking of lab samples of concrete cylinders and their tagging for identification purposes. All these activities enhance the student's feeling of being a part of the construction site system.



Figure 1. Site visit to an apartment building construction (masonry). Students bending steel bars with the help of construction workers and supervised by professor and site engineers.

This amplified vision backed by the construction site visits allows the increment of the communication and interaction between professor and students, using the same structural language and revitalizing a more dynamic and fluid academic relation. They have now, common experiences and in further topics, they can go back to what they saw in previous CSV.

In the pandemic period, due to health restrictions and social distancing, many projects were suspended, and the ones who continued, applied restrictions to the possibility of visitors access to the site, and so the student's construction site visits for academic purposes were also suspended. That is why we applied different strategies to continue with these experiences for the students. One of these strategies developed and applied were the "virtual site visits" as an experimental lab where the professor, with the support of a portable personal broadcasting system (cell phone, tablet or a go-pro camera), goes into the construction site by himself broadcasting a live streaming where the students are connected via Zoom Sessions and developing a permanent interaction between them, the professor and many construction site workers.

The professional experience of the professor is fundamental to perform a visit focused on the important sights of the site, showing different and important work aspects of the structural construction and to find the points of interest where the theoretical concepts seen in the classroom can be directly applied at the construction site. It is important to have live interviews with construction workers, architects, structural engineers and sometimes with the owners or stockholders of the new project.

When the period of social proximity restrictions ended, construction site visits started again, nevertheless, the available spaces are limited for safety and health matters, in addition to the physical distances from campus to the construction site, it is common that many students don't have the opportunity to assist to the site visit and they lose the chance to enhance their structural perspective.

From that point is where the possibility of using the experience developed during pandemic times emerges and it is necessary to adapt it to the new normality by having hybrid construction site visits with students physically at the site and streaming live broadcast using Zoom Sessions with interaction in real time between students in site, students in house, professors, construction workers and everyone related to the construction site, answering questions, solving doubts and giving a new point of view about the structural behavior related to the construction site insights.

2 Methodology

The process described in the introduction has been evaluated by the application of polls using Google Forms to a number of students who participated in the construction site visits in both ways, physically at the site or virtually at the distance. I am trying to find their perception on the construction site visit advantages and benefits and evaluate the option to have them both, with physical presence or virtual presence.

The students that applied the poll are enrolled at different structural engineering topics such as Concrete Structures Design, Steel Structures Design, Foundation Engineering and Structural Engineering Capstone.

The students are between the 6th and the 9th semester in Civil Engineering or Architecture and their age is 21 years old average.

During the pandemic period, we performed several construction site visits using a virtual format with a live streaming broadcasting using Facebook Live first and then switched to Zoom Sessions. After the pandemic was reducing its global levels, we started applying a hybrid format, with a live streaming broadcasting along with students physically at the construction site, approximately 20-25 students at the site and 30-40 following and participating in the live streaming. I start with a general tour at the construction site to identify points of structural interest and then, after the general tour is over, I come back to specific points to show the students how a structural drawing become a structural element, either structural steel or reinforced concrete, we go to every important structural element and see how it is done and how it interacts with the whole structure to ensure an adequate structural behavior. I verify with the students how the theoretical contents seen in the classroom become alive and applicable at every point of the construction site.

In the time of developing this paper, two semesters in 2022, we visited several construction sites in progress from I am documenting three of them: a) We visited a four stories apartment building with a masonry and bearing walls structural system, b) we visited a 2 stories commercial structural steel building with rigid frames and different slab systems, c) we visited a public hospital construction with precast prestressed concrete structure, d) we visited a four stories masonry commercial building, e) we visited a 59 stories high-rise building in a reinforced concrete structural system with post tensioning slabs and f) we visited a campus facilities building particularly at the construction of a retaining wall using the Berlin system.



Figure 2. Site visit to an apartment building construction (masonry).



Figure 3. Site visit to a commercial building (structural steel).



Figure 4. Site visit to a public hospital (prefabricated prestressed concrete).



Figure 5. Site visit to a structural steel commercial building.



Figure 6. Site visit to a 4 stories masonry building.



Figure 7. Site visit to a high-rise building (59 stories)



Figure 8. Site visit to a retaining wall construction using “Berlin” system.



Figure 9. Zoom visit to a cable stayed bridge

In the construction site visits described, the hybrid model took place having students physically at the construction site and streaming live to another group of students who were not able to be at the construction site, either if that was because of number of visitors allowed at the site restriction or because a personal matter of distance, health or economy. Distance between campus and site is a very important matter because most of times, the site is far by many kilometers, we ask students to arrive by their own means to the construction site or we offer limited space free transportation. When the students don't reserve on time, and they don't have their own means to arrive, they can follow the CSV by the live streaming connection.

We have an average of 25 students physically present at the site on each visit and 40 students in a virtual presence. After having done the construction site visits, polls were applied to evaluate students' perception in terms of the effectiveness of the site visits related to their structural concept learning, and a comparison between physical visits and virtual visits making emphasis at the advantages of each one of the options available.

The generated interaction [1] either physical or virtual, is much more suitable compared to the one experienced by only watching pictures or pre recorded videos, mainly because we can go deeper into the concepts, focusing in the most interesting points of the construction site, we can interview and interact with the construction workers, architects, structural engineers and every person related to the construction site, earning a lot of experience in these kind of activities.

In the new Tec21 Model at Tecnológico de Monterrey, that is a Challenged Based Learning Process [2], it is fundamental the direct application of the theoretical knowledge acquired in classrooms to real-life problem situations, and in these construction site visits, we can directly watch the real-life application of these structural concepts and be close to the problem-solving environment related to it.

3 Results

After two semestral periods of 2022, and several construction site visits (6 of them documented in this paper), I applied polls to 121 students who participated in most of the visits taken place in this period. They answered the polls about their perception and experiences achieved in these site visits either if they been in a physical presence or virtual presence during the visit. The poll was applied using 15 questions in Google Forms. In this paper I am going to take a close look at only 5 of these questions, that I considered the most relevant by means of this paper.

3.1 Results analysis according to the poll's answers

According to the answers obtained in the polls and questionnaires applied, the results are evaluated and analysed, not from every question and poll applied, but from the ones I considered the most applicable by the means of this paper.

3.1.1 Structural engineering areas and topics from where students participated in the site visits.

The participant students were enrolled at different structural engineering topics during the period of study. The distribution of these students is as follows:

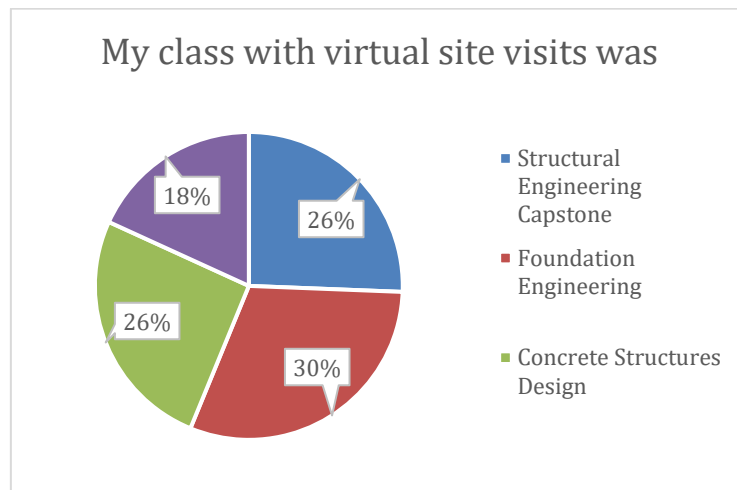


Figure 10. Participants distribution by topic.

Students were asked about the learning impact in the different academic areas covered at the construction site visit and the advantages obtained related to ease the structural concepts learning.

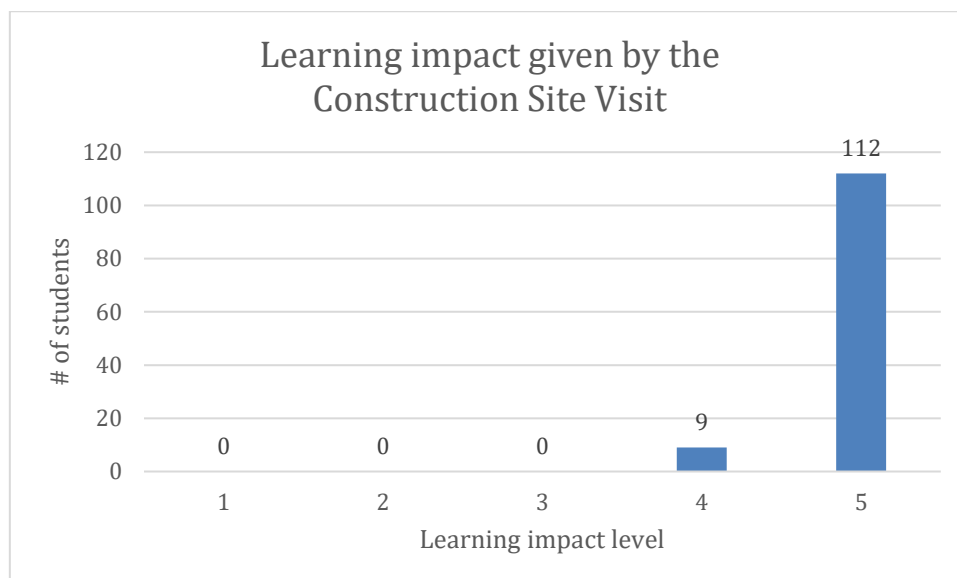


Figure 11. Participants perception of academic impact from the site visit.

In the students' answers, it can be appreciated that they are aware of the relevance of site visits in the academic knowledge and competencies achieved during their civil engineering education. With 112 students with a positive perception and only 9 students with the second higher option, they show their appreciation on this activity.

3.1.2 Students' commentaries related to the site visits.

Students were asked to express comments and opinions related to the site visit. In Fig. 5 some of the comments are shown, we selected only ten of them as a general highlight about them.

Participant #1	I liked the teacher's comments and explanations, the doubts were answered in the best possible way
Participant #2	It was a cool experience, useful explanations. Don't stop making them frequently
Participant #3	I think it is nice to have a classroom break, not only being at the construction site but learning as well
Participant #4	I enjoyed it a lot, very interesting
Participant #5	I really liked the visits, learned a lot at them
Participant #6	I'm a Civil Engineer to be so I really enjoy being at the construction sites and learn much more than in the classroom
Participant #7	Eventough it was a virtual site visit, I really enjoy it, I hope next time I may be at the site
Participant #8	You have to make them more often
Participant #9	I don't like the theory as much as I like site visits, it's a much better way to learn structures
Participant #10	Really useful and I am very satisfied with what I learn there

Figure 12. Examples of comments of the student's opinion on the construction site visits. (Comments were translated from Spanish to English by the author)

As we can see in the different answers, the students are in a positive attitude about the site visits and the hybrid version of them, being aware that sometimes it is not possible to be physically at the construction site, the alternative of being virtually at the site is attractive and generates expectations in them. There were 75 student's commentaries related to the CSV and we chose 10 of them that summarise the general opinion of the students. It is very important to make emphasis that there was no negative comment or opinion related to these activities.

3.1.3 Qualitative elements evaluated in the site visits.

The students were asked to select qualitative elements that can be appreciated from the site visit. They had four options to express their points of view: a) the general tour of the construction site, b) the professor's explanation, c) the construction sights and 4) the streaming quality. They were able to choose one or multiple choices.

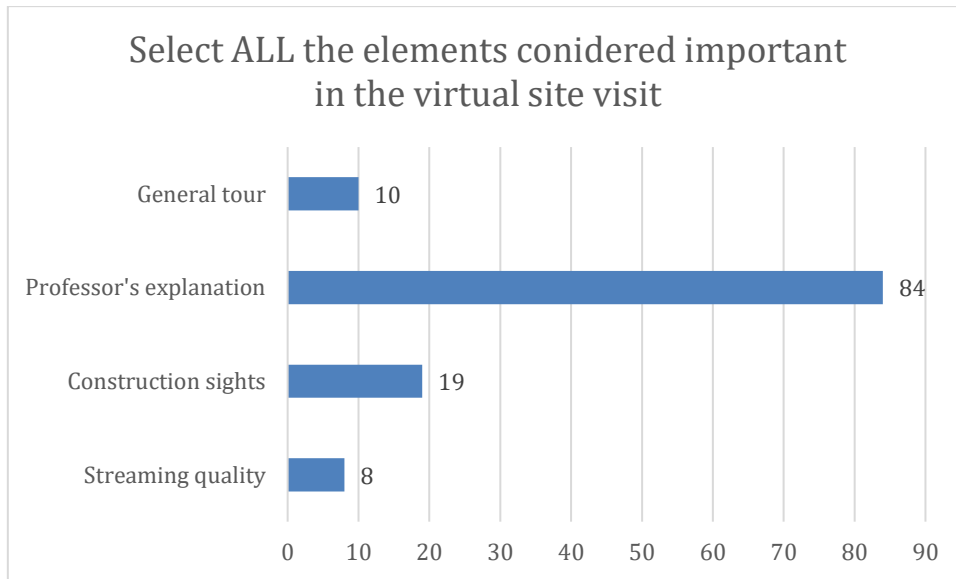


Figure 13. Qualitative elements of the construction site visit according to student's point of view.

As we can see, the greater value is in question related to professor's explanation related to what they are watching at the construction site, it means that they understand that site visits are not only field trips to have fun and be out from the classroom, but they are also acquiring aggregated value to the theoretical concepts that have been seen in classes.

3.1.4 Virtual Sites Visits vs Physical Site Visits

This point of the article is the spotlight, we are asking the students if they like better the physical site visits or the virtual site visits, and as we can appreciate in Fig. 8, 102 out of 121 are most likely supporting the physical site visits but, when we change the point of view asking them if they like the virtual site visit as an complementary alternative to physical site visits, as we can appreciate in Fig. 9, 115 out of 121 say that they support this option.

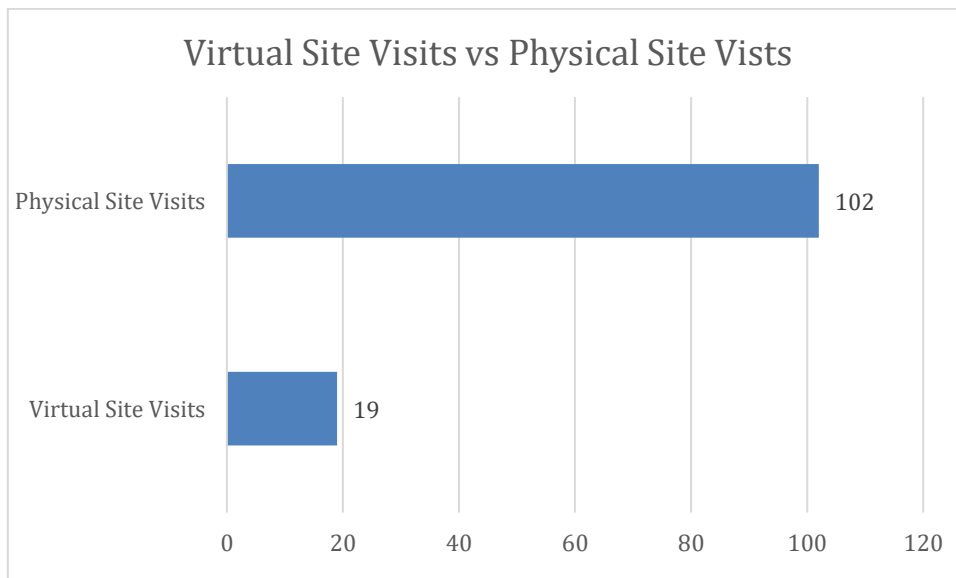


Figure 14. Comparison between Virtual Site Visits vs Physical Site Visits.

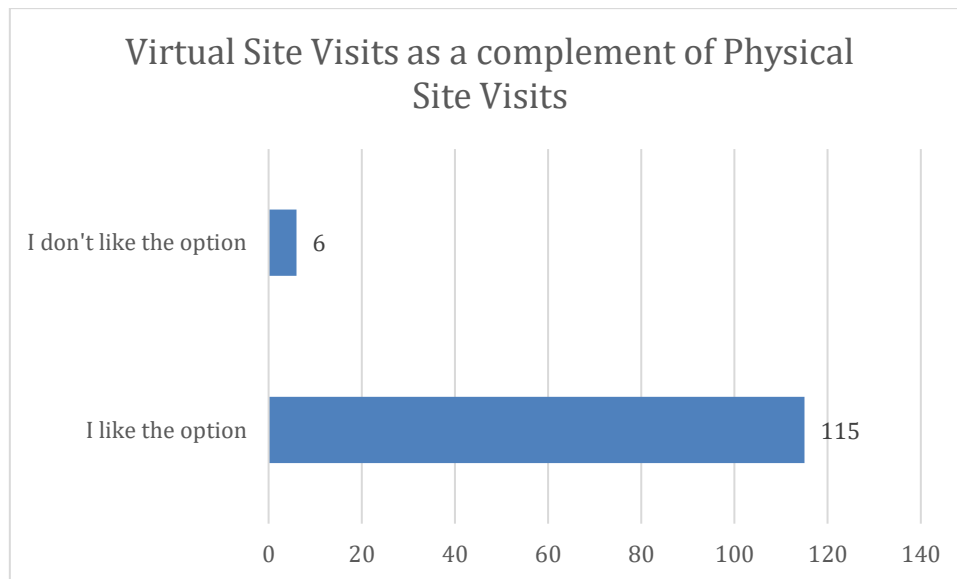


Figure 15. Students' perspective of virtual site visits as a complement toll for physical site visits.

The students have experienced, most of them, both alternatives of being at a construction site, physically and virtually, they can compare what they got in each case, so they have a strong point of view about the possibilities of both approaches.

Having the virtual site visits as a unique option is not seen with a positive point of view but having it as an alternative in difficult times or in a restricted situation, they change their opinion to a very supporting one. The perception of the knowledge and experience obtained at the CSV is highly positive, the students express at the classroom after the visits their newly obtained knowledge with proud and happiness, they frequently use expressions like: “as we saw at the CSV” or “at the CSV the structural engineer explained us this...”. The use of these expressions shows the impact produced in them at the visit and how important for their motivation they are.

4 Conclusions

The possibility that students may attend construction sites is especially important in the completion of academic issues of the Civil Engineering curricula [3]. The students recognize the importance of the opportunity of being able to experience these activities as a compliment of their theoretical learning process. From the results shown we can state that the students noticed the value and importance of construction site visits but also, after having gone through pandemic times when we learned to face health and social restrictions in almost every daily life situation, they are aware of the necessity of having alternatives already proven to work. In this case, the virtual site visit as a complement having a hybrid possibility to go through this construction site visit is a feasible alternative that may bring the opportunity to those students that, because different situations of restriction, are not able to be physically at the construction site.

The use of this methodology in future scenarios after what we have learned during pandemic times will be helpful in diverse manners: a) When there is a limitation in-site of the amount of people admitted to the construction site, we can have students participating at the site and in a remote virtual way using the streaming tools, b) when the construction site location is far from campus facilities and the transportation costs are high, we can take small groups to the site and

the other students can follow the site visit in zoom or any streaming channel available, c) when a student or group of students are limited by health issues and cannot be at the visit, they are able to participate using this process.

We have to continue improving our performance having new tools and increase the possibilities. Trying to find better ways to perform the streaming like cameras installed in our safety equipment (go pro) microphones with more fidelity and any other equipment to let us improve the quality of the broadcasting.

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6 References

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