A novel approach of inspection methodology in fabrication industry post COVID-19

Manoj Kumar Yadav¹, Darshan Gambhava², Lalit Kumar³ Shailendra P Singh⁴
¹, ³, ⁴Department of Mechanical Engineering, Inderprastha Engineering College, Ghaziabad, Uttar Pradesh, India, 201010
² Indian Institute of Welding, Delhi Branch, New Delhi, India, 110058

e-mail: manoj.yadav@ipec.org.in

Abstract. The virus SARS-COV2 also known as COVID-19 is a pandemic that affecting the entire world. During this tough time, all the industries, manufacturing units, and the related entities are either closed or partially open. During this pandemic, the fabrication industry is also got affected. During the lockdown, industry people are going through various internet platforms and technology to accomplish their work. The fabrication and welding inspection are also part of it. Conventionally it was done physically by inspectors. inspecting the weld. But, during this tough time, some new methodologies of inspection such as the use of the high-resolution camera, use of Industry 4.0, and smart glasses are suggested in this paper for various fabrication inspection activities without going to the site. The cost of the inspection also can be reduced by adopting these new approaches along with the demand for maintenance of social distancing needed during COVID-19.

Keywords:

1. INTRODUCTION

In the current scenario, the entire world is suffering to fight with the pandemic SARS-COV2 also known as COVID-19. Millions of COVID-19 cases have been confirmed all over the world. Pandemic is made by two Greek words “Pan” and "Demos" which means "All" and "People" respectively. This word was tossed by medical experts for the epidemic that is spreading in several countries as well as continents at an identical stretch of time. Dense societies like Asian and African continents are at the most vulnerable state to the new pandemic COVID-19[1]. It is also spreading in North America, Europe, and the Middle East at a very fast pace[2].

The SARS was an epidemic that affected the world in the year 2003-2004. But, the majority of cases of SARS was in China mainland. SARS very badly affected the economy of the entire world. The growth rate of China and Hongkong was declined by 3% and 4.75% respectively in quarter-2 of 2003. It was witnessed that the COVID-19 is more dangerous than the SARS and this pandemic also affected more areas of the world, so in turn, it would show a more adverse effect on the world economy.

To minimize the fatality rate, the World Health Organization (WHO) issued some guidelines to slow down or stopping this virus at the community level. WHO issued personal, social, and travel
measures that can help to reduce the spreading of COVID-19[3], [4]. It is a global crisis that is affecting humanity, economy, social opinions, and also the peoples’ daily lives[5]. All the businesses get affected by this crisis because of the social distancing with totally or partially lockdown in different parts of the world. No one knows or can predict the period of a lockdown or the related restrictions as well as the path of economic recovery in future[6]. In this worldwide health calamity, every sector is craving to adopt new approaches or technologies which can fulfill their requirement.

The manufacturing and fabrication industry contributes a major share in the world industrial setup. Some of the studies said that manufacturing sectors will get triple hit- one is due to direct supply disruption, second due to supply chain contagion, and third due to demand disruptions[7], [8]. The stated hits will hit the economic growth of the manufacturing industries. The industry has to improvise the traditional way of working in the field of manufacturing, quality check, sales, and marketing as well. To curb the losses due to the advisory and prevention in various direct and indirect fields of working, the industries have to cut some of their financial burdens by using the internet based new technologies and platforms available in the market. During and after the current global scenario, many organizations can take it as an opportunity in the crisis. So, there is a great prospect and need for research to uplift the declined economy of the world by using new technologies like AI, IoT, and Industry 4.0[9].

In the manufacturing sector, welding and fabrication industries play an important role. For inspection of various fabrication stages, the inspector has to travel via some means to the site in conventional days. But, due to curbs in traveling in public transport and aviation industry[10], it seems to be a tough task to perform on-site weld inspection. The safety of engineers, workers and investigators is the prime aspect for any industry. The current scenario of COVID-19 floated the safety issues at work site and discussed from march 2020 to till now at various government and non-government platforms. In this paper, it was tried to explore the novel and innovative approaches, that can be utilized for weld inspection without or minimum going on-site and physically carry out the inspection. The new approaches will solve the problem faced during pandemic to a great extent.

2. NEW APPROACHES TO INSPECTION METHODOLOGY

The society sees another influx of research in the natural and the clinical sciences for the prosperity of human advancement. There is also an imminent requirement for the research to improve the global economy, which has taken a tremendous beating and is unlikely to recover shortly. Professionals are facing a lot of difficulties in maintaining quality.

This new situation in the world demands less travel, social distancing, cost-cutting, and of course without loss of efficiency and quality. The same cannot be fulfilled by the conventional way that we were adopted for the last few years. The industry must update and come out with new approaches to get the final product with the same or better quality. In the future, this may change to a new normal.

Inspection is an important activity in fabrication industries. From start to end there are numbers of activities involved in the fabrication/manufacturing of the product. After completion of each activity, various quality checks are required to assure the quality of the part to perform the intended purpose of the product. These quality checks are known as inspection stages. The inspection stages are to be verified/inspected by the qualified quality control inspectors at the Manufacturer's end. Generally, the verification/inspection is performed by the manufacturer's inspector, third party inspector, and/or client inspectors.

A document defining the inspection stages of all the above inspectors got prepared, generally known as a quality control plan[11] (QCP) / Inspection test plan (ITP). In general, Inspectors have to check/witness physically all the activities at the site/workshop according to QCP/ITP. Third-party inspectors (TPI) and client inspectors have to visit the site/ workshop as defined by these documents as “inspect stages”[12], [13].

These inspection stages can be categorized into two categories named as “Witness” or “Hold”. In the witness category, the inspector may or may not present for the inspection but in hold category, the inspector shall be present for the same. In most cases, these activities are the on-call basis for TPI or client’s inspector where they have to be present for the activities at the offered time by the manufacturer. All such stages of inspection are defined based on factors such as criticality of the activity, confidence in the manufacturer’s system, client’s requirements.
General activities in fabrication are demonstrated in figure 1 that required inspection at different stages, such as material identification, dimensions measurement, welding activity, non-destructive examination, pressure test, or functional tests.

![Diagram](image)

**Figure 1. General Inspection Steps in Fabrication of Pressure Vessels**

In the current situation some new approaches, like Remote Inspection by using a camera, live streaming of the fabrication and inspection, etc. can play a decisive role to assure the quality of the product. This is the extension (addition of more application) of the conventional existing approach of the inspection. The remote inspection concept is available currently where there is no accessibility or a very unsafe condition for a human to go and inspect. The introduction of “Remote Inspection” can reduce all the costs incurred like traveling and lodging[14]. The Remote Inspection can check the quality by using real-time data with the help of Industry 4.0 concept or by using the technologies using sensors and transducers.

2.1 Remote Inspection using High-Resolution Camera

It was reported that onsite visual inspection by the inspector assessed around 10% of the total labour expenses for fabricated products[15]. The demand for the current scenario is to reduce this cost as much as possible. So, to cope up with this issue, some new approaches can be suggested.

In the proposed new approach, the inspection which is currently done physically by the qualified inspectors can be replaced with the camera at site and inspectors at the remote location, probably home or office. For example, if a remote inspector has to witness and identify the plate material for, he/she can do it the same by using a remote inspection methodology. A manufacturer can show the material and identification through live video to inspector using a high-resolution camera and then a unique identification may be marked on the plate or component near original identification as per inspector’s instruction or material traceability procedure. Photographs of the same shall be attached as a part of reports.

Another stage could be the inspection of the welding set up of the component. Conventionally, an inspector must go to the production site and verify it physically. However, in the proposed approach an inspector will connect with the manufacturer through video platform and instruct them to show all the measurement and setup parameters, i.e., material identification, groove angle, root gap, root face, etc. The same can be recorded as evidence also. A report can be prepared based on this inspection with the digital signature.

Another case is the mechanical testing laboratory. The inspector has to visit the laboratory to witness the testing as per the schedule and carry out testing witnesses. However, with the new approach, the inspector can verify remotely each and every minute details of the test specimens through a live video platform and allow the laboratory to conduct testing. The inspector will witness the test conducted and record the results through a live video platform and signed the reports digitally.

2.2 Monitoring the process by using Industry 4.0

In the fabrication inspection, sometimes continuous monitoring of the process like welding is also important. The same can be implements as a part of the Internet of Things (IoT) and Industry 4.0. These are the next level of industrialization and making future-ready industry. It is a revolutionary step
to digital networking of connecting all things, machines, and manufacturing in real-time. It promotes real-time communication between all the entities attached through the internet[16].

In case of a continuous process like welding, the welding parameters from the corresponding documents (Welding procedure specification) can be fed into the machine through digital WPS or form anywhere in the world through machines having equipped with Industry 4.0 accessories[17]. Through these types of machines, the inspector can monitor all the welding process parameters from his/ her office on the computer or mobile with the help of data transfer through the data management system as shown in figure 2 [18]. He/she can even control the parameter while just sitting a thousand miles away from the manufacturing site by just using the software on his/her computing system[19]. A report can be prepared based on the activity and clear the activity for the next stage.

The same concept can be utilized and implemented for the Non-Destructive Examination and pressure testing or functional testing by providing data feed to the inspector.

2.3 Monitoring with the help of Smart Glasses

In the modern era of technology, smart glasses also can be a way to monitor all the operations by just sitting at the office far from the actual site. Using smart glass, an expert, inspector, or adviser sitting at a distant location can view and examine through live streaming. The viewer and the person sitting at a distant location also can interact with using internet-enabled smart glasses. The smart glass is the combination of the hardware and the cloud-based software on the web portal[20]. All the live streaming is managed through big data at cloud service as shown in figure 3.

The inspector or advisor can receive real-time data from the manufacturing or fabrication site or installation site and provide input to the people working at remote sites. This is an expensive technology but gives various add on benefits like recording, GPS tracking, barcode reading, etc. Instant support and real-time management can be done by using this technology. The traveling cost which is a non-value-added activity can be eliminated and the time required for traveling to the inspection or installation site can also be eliminated using smart glass technology.

![Welding Data Management System in Industry 4.0](image)
3. DISCUSSION

This new approach will help in many ways. First and foremost is that the new approach will allow the industry to fight with the current situation which demands social distancing and restricted travel. Also, the safety of the stakeholders from getting infected with such viruses.

The physical attendance of the inspector on-site always involves an extra cost which includes traveling, lodging, boarding, time spent for all the above activities. All these activities are non-value adding activity and removal of these activities provides cost benefits to all stakeholders. The new approach has the potential to cut all such non-value-adding activity to increase productivity.

In the above examples with the remote inspection, we can save all travel lodging and boarding, and time for all such activities. An inspector will be available through a remote device or streaming platform when the inspection is ready by the manufacturer. The inspector will finish his/her activity and spend the time which is required to spend on the planned activity. after completing an activity that the same inspector will be available for the next task, which in turn improves the overall efficiency by cutting non-value-adding activity of the total operation. In addition to that in case of critical inspections, one or more inspectors or subject matter experts can be engaged to complete the activity, which may sometime save the time for re-work. However, if there is a demand for physical inspection of the product or the project then it must be continuing in a conventional way. The use of the right mix of the conventional and new approaches for inspections should be adopted as per the product requirement. This new methodology has very high potential to reduce the overall cost of the product and the project by with complying most health and safety requirements.

Every new approach has some challenges that shall be overcome with the right approach to get the maximum advantage. Some of the major challenges in the way to adopt the above-discussed approaches are

- The robust and seamless infrastructure and connectivity from the location of activity to the inspector.
- Training and qualification of the people involved
- The adaptability of the system to the current working method involved people in the new methodology.
- In some case confidentiality of the manufacturer’s technology
- Data security while online streaming and storage

With the new approach, Quality Control Plan (QCP)/Inspection Test plan (ITP) must be introduced with new stages for inspection i.e. “Remote Witness”, “Remote Hold”. All these stages are in addition to currently used conventional stages like a witness, hold, and review. These stages can be decided based on the factors considering criticality in the inspection activity, consequences to the upcoming activities, availability of infrastructure for remote inspection, trained manpower to execute the remote inspection at location and remote center, etc.
The current crisis can be taken as an opportunity and using the right mix of the above inspection stages in current practice. It reduces the total cost of the product with a considerable reduction in the inspection cost for the component and project in total.

4. CONCLUDING REMARKS

COVID-19 pandemic is a health crisis for the universe. This pandemic has influenced the wellsprings of supply and impacts the worldwide economy. It has presented new difficulties to the worldwide industries and supply chain network. All legislatures, wellbeing associations, and different specialists are constantly focussing on distinguishing the cases influenced by the COVID-19. Social insurance proficient face parcel of challenges in keeping up the nature of human services in nowadays. COVID-19 has quickly influenced our everyday life, organizations, disturbed the world exchange and developments. The different businesses and areas are influenced by the reason for this ailment; these incorporate the pharmaceuticals business, solar-powered force segment, the travel industry, Information, and gadgets industry. There is a requirement for superior multi-disciplinary and translational research to cope with COVID-19 and its effects.

The following conclusion can be drawn after considering various new approaches of inspection during fabrication process under current situation arises due to COVID-19:

i. The introduction of remote inspection using a high-resolution camera is a suitable option for the conventional approach of inspection. It can be nicely and intelligently blended with a conventional approach wherever needed. This cost of inspection can be minimized by using this approach.

ii. Industry 4.0 can be used in developing a new algorithm to further transform industries towards the smart industry, where industries get equipped themselves for the danger of such diseases/infections in the future. It will provide the real-time data to the inspector and the inspector/expert can change the parameter of the machine if need. The initial cost for adopting this approach is a little bit higher but can open a new horizon of the smart world equipped with very interactive smart technology.

iii. Smart Glasses is also an option of remote inspection that can provide real-time data. It also connects the expert or inspector to the manufacturer without going there. This technology needs a headgear device equipped software and internet which can live stream the things going on the fabrication site. So, the troubleshooting will be faster and more accurate.

iv. The adoption of the new approach has some challenges like the initial investment in infrastructure, adaptability, training to the user, the security of data, and many more. So, the challenges have to be taken care of to adopt any new approach to inspection.

To fight with the current unpredictable situation of pandemic COVID-19, the fabrication industry has to think about the new approaches of inspection, as they are the demand of the current crisis and also for any future such type of situation. On future other technologies like artificial intelligence, machine learning etc. can also be used with integration of robots to inspect the quality and soundness of weldment and structure.

REFERENCES

[1] T. P. Velavan and C. G. Meyer, “The COVID-19 epidemic,” 2020.
[2] J. Bedford et al., “COVID-19: towards controlling of a pandemic,” The Lancet, vol. 395, no. 10229. Lancet Publishing Group, pp. 1015–1018, 28-Mar-2020.
[3] “Advice for public.” [Online]. Available: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public. [Accessed: 22-Apr-2020].
[4] M. Lipsitch, D. L. Swerdlow, and L. Finelli, “Defining the Epidemiology of Covid-19 — Studies Needed,” N. Engl. J. Med., vol. 382, no. 13, pp. 1194–1196, Mar. 2020.
[5] Y. Yang et al., “The deadly coronaviruses: The 2003 SARS pandemic and the 2020 novel coronavirus epidemic in China,” Journal of Autoimmunity, vol. 109. Academic Press, p. 102434, 01-May-2020.
[6] N. Fernandes, “Economic Effects of Coronavirus Outbreak (COVID-19) on the World Economy,” SSRN Electron. J., Mar. 2020.
[7] P. Jandrić, “Postdigital Research in the Time of Covid-19,” Postdigital Sci. Educ., vol. 2, no. 2, pp. 233–238, Apr. 2020.
[8] R. Baldwin and B. W. di Mauro, Economics in the Time of COVID-19. CEPR Press, 2020.
[9] A. Haleem, J. M. Islamia, M. Javaid, J. M. Islamia, R. Vaishya, and I. A. Hospitals, “Areas of academic research with the impact of COVID-19 American Journal of Emergency Medicine,” Am. J. Emerg. Med., no. April, pp. 4–7, 2020.
[10] A. Haleem, M. Javaid, and R. Vaishya, “Effects of COVID 19 pandemic in daily life,” Curr. Med. Res. Pract., Apr. 2020.
[11] N. C. Anderson and J. V. Kovach, “Reducing welding defects in turnaround projects: A lean six sigma case study,” Qual. Eng., vol. 26, no. 2, pp. 168–181, 2014.
[12] Y. Sun, P. Bai, H. Y. Sun, and P. Zhou, “Real-time automatic detection of weld defects in steel pipe,” NDT E Int., vol. 38, no. 7, pp. 522–528, Oct. 2005.
[13] Y. Javadi et al., “Continuous monitoring of an intentionally-manufactured crack using an automated welding and in-process inspection system,” Mater. Des., vol. 191, p. 108655, Jun. 2020.
[14] D. Colombo, B. M. Colosimo, and B. Previtali, “Comparison of methods for data analysis in the remote monitoring of remote laser welding,” Opt. Lasers Eng., vol. 51, no. 1, pp. 34–46, Jan. 2013.
[15] H. I. Shafeek, E. S. Gadelmawla, A. A. Abdel-Shafy, and I. M. Elewa, “Assessment of welding defects for gas pipeline radiographs using computer vision,” NDT E Int., vol. 37, no. 4, pp. 291–299, Jun. 2004.
[16] G. Posch, J. Bruckner, and H. Ennsbrunner, “INDUSTRY 4.0 IN WELDING White Paper,” 2017.
[17] R. French, M. Benakis, and H. Marin-Reyes, “Process monitoring and industrial informatics for online optimization of Welding Procedure Specifications (WPS) in Gas Tungsten Arc Welding (GTAW) - Industry 4.0 for robotic additive remanufacturing of aeroengine components,” in ICARM 2018 - 2018 3rd International Conference on Advanced Robotics and Mechatronics, 2019, pp. 812–817.
[18] M. Benakis, C. Du, A. Patran, and R. French, “Welding process monitoring applications and industry 4.0,” in IEEE International Conference on Automation Science and Engineering, 2019, vol. 2019-August, pp. 1755–1760.
[19] D. Mishra, R. B. Roy, S. Dutta, S. K. Pal, and D. Chakravarty, “A review on sensor based monitoring and control of friction stir welding process and a roadmap to Industry 4.0,” Journal of Manufacturing Processes, vol. 36. Elsevier Ltd, pp. 373–397, 01-Dec-2018.
[20] L. B. Christensen and M. P. Engell-Norregard, “Augmented reality in the slaughterhouse - a future operation facility?,” Cogent Food Agric., vol. 2, no. 1, Jun. 2016.