Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht

Band: 6 (1960)

Artikel: Gamma radiography of structural concrete

Autor: Forrester, J.A.

DOI: https://doi.org/10.5169/seals-7078

VI3

Gamma Radiography of Structural Concrete

La gammagraphie du béton

Röntgenographische Prüfung von Bauwerksbeton mit Gammastrahlen

J. A. FORRESTER
B. Sc., Cement and Concrete Association, Slough, England

Gamma rays are like X-rays and have the ability to penetrate material which is opaque to light. The principle of gamma radiography is to record on a photographic film the intensity of radiation transmitted through the material being examined. The attenuation of radiation is almost proportional to the apparent density of the material, therefore, any internal feature which is of a different density to the bulk of the material can be seen on the film. In practice a radioactive isotope generating gamma rays is exposed on one side of a specimen and a film in a light tight cassette is positioned on the opposite side. Areas of high and low density in the material produce light and heavy blackening of the film respectively.

Gamma radiography of metal castings and welds is well established, but only recently has use been made of this means of non-destructive testing for examining concrete [1], [2].

The advantages of gamma radiography over X-radiography for structural

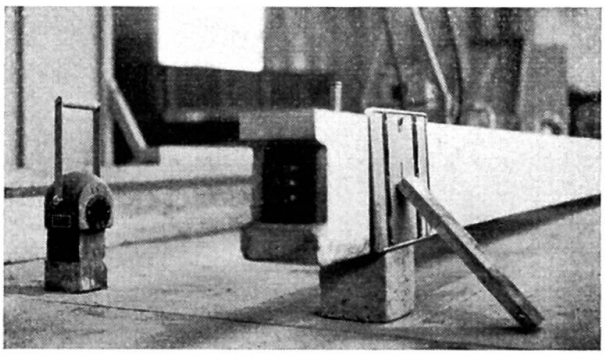

Fig. 1.

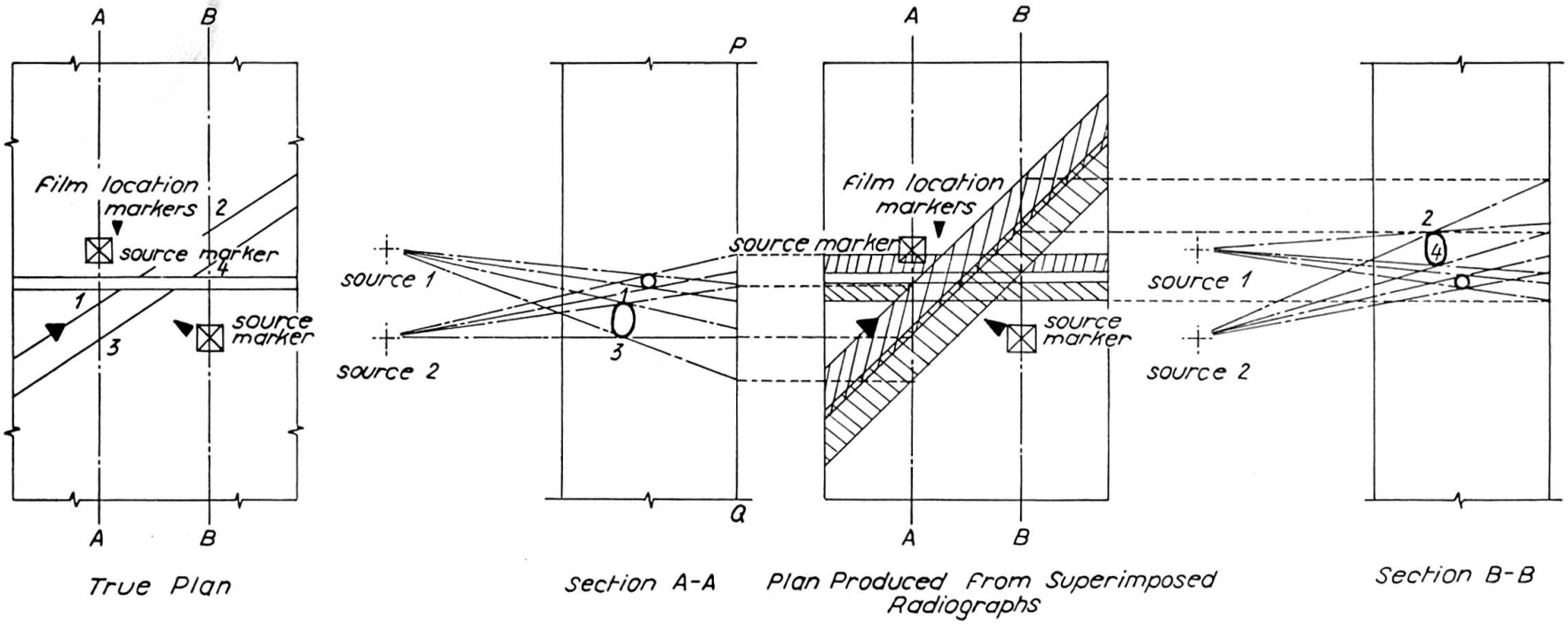
A
B
Film location markers
2
source marker
4
1
3
source marker
A
B
True Plan
P
source 1
source 2
1
3
Q
Section A-A
A
B
Film location markers
source marker
source marker
A
B
Plan Produced From Superimposed Radiographs
source 1
source 2
2
4
Section B-B

Fig. 2.

concrete examination are greater portability and initial cheapness of the apparatus, negligible running costs and the ability to penetrate thicker sections of concrete with the higher energies of radiation available from isotopes such as Cobalt 60.

The simplicity of the arrangement can be seen in Fig. 1 which shows the radiography of a prestressed beam. The radioactive source, which here is 275 millicuries of Cobalt 60, is in the container on the left and the film is in the cassette to the right of the beam.

Description of Some Radiographs and Radiographic Investigations

Radiography can be used to locate and identify steel reinforcement and voids in concrete as the presence of either of these results in a local variation in density in the concrete.

Over a period of time a fairly extensive library of radiographs has been prepared and collected at the Cement and Concrete Association showing concealed features and faults in concrete and some of these, together with their interpretation are described here.

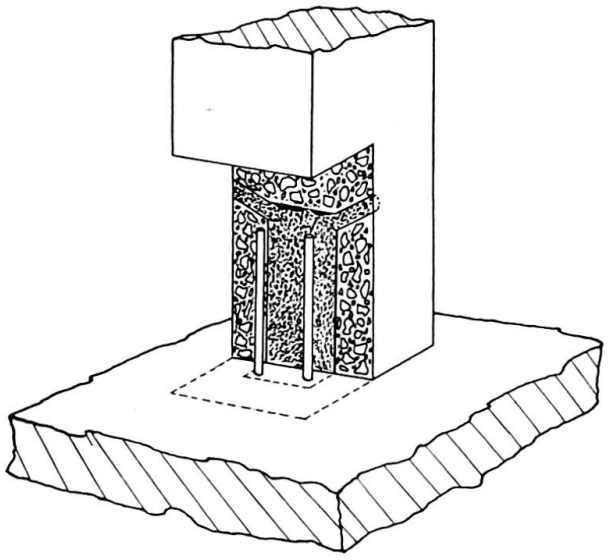

Fig. 3.

An indication of the presence of reinforcement bars is simple with radiography, but an identification of bar size and three dimensional spacing requires that stereo radiographs be taken. A simple photogrammetric technique illustrated in Fig. 2 enables orthographic drawings to be prepared from the stereo radiographs.

Radiography has been used for investigations into the efficiency of mortar jointing. Fig. 3 shows a familiar method of jointing used in a multi-storey

building. Here a column with a rectangular cavity at the base is dropped on to a spigot of reinforcement bars and the chamber is subsequently grouted with mortar. It was suspected that on a particular site where this joint was being used, the chamber was not being filled completely and that subsequent stress transmission down the column would result in movement. A sample

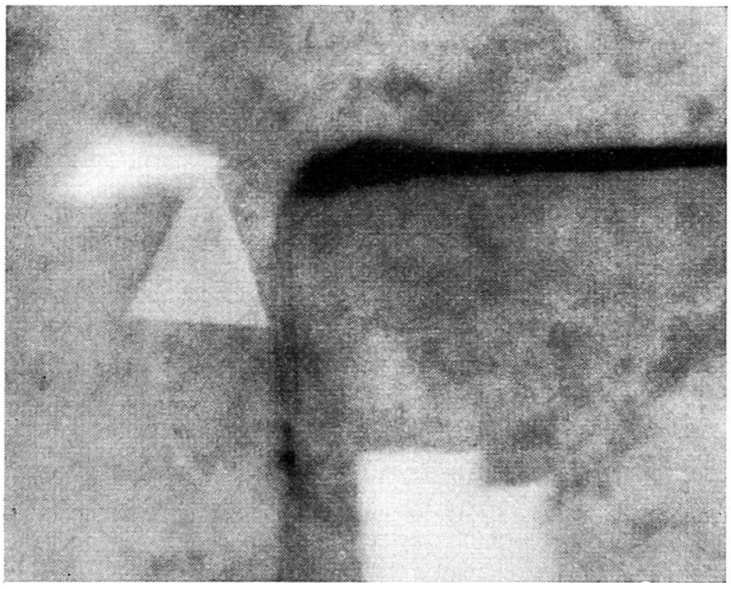

Fig. 4.

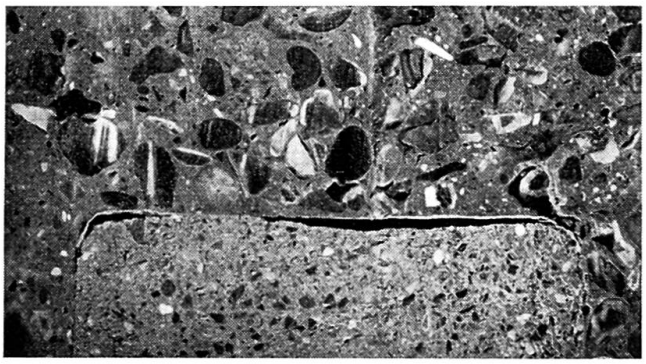

Fig. 5.

joint was made, radiographed, and afterwards cut open to confirm the findings of the radiograph. Fig. 4 shows one of the radiographs taken through this joint and the voids at the top and the side can be seen as dark areas. A cut section of this sample joint shown in Fig. 5 shows the voids at the top of the chamber and the presence of building paper accounts for the slight voidage at the side of the chamber. As the result of this investigation the design of the chamber was modified to ensure complete filling.

Identification of grouting flaws in post tensioned prestressed concrete is very important and Fig. 6 shows a radiograph of such a flaw in a prestressed

beam. In Fig. 6 voids due to water trapped in the duct during grouting are shown. This beam was subsequently cut open in order to expose the flaws and the section radiographed is shown in Fig. 7.

A recent gamma radiographic investigation in Great Britain was conducted at the new Dungeness lighthouse[1]), shown during construction in

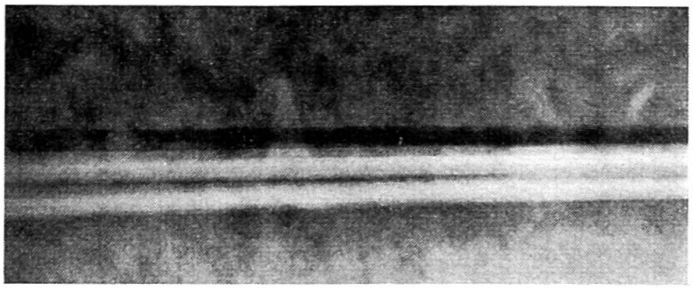

Fig. 6.

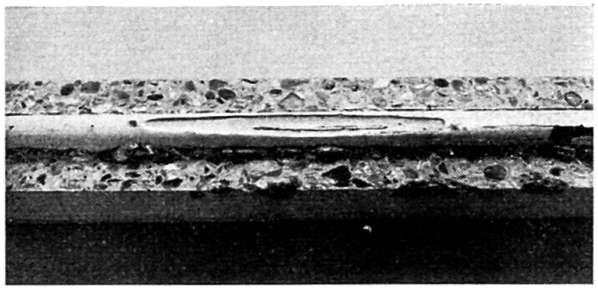

Fig. 7.

Fig. 8. The lighthouse is constructed of cylindrical drums of precast concrete and is prestressed vertically through the walls of the drums. The prestressing wires fall off in number up the height of the tower and to check on the grouting efficiency it was decided to radiograph the top anchorages in each duct. This job was carried out by commercial radiographers[2]) using techniques developed at the Cement and Concrete Association. A $7\,^1/_2$ curie Cobalt 60 source in a source holder weighing 6 cwts. was lowered down the vertical axis of the tower and held at a level coincident with the ring of anchorages (Fig. 9). Cassettes containing film were strapped to the outside of the tower adjacent to the anchorages (Fig. 10) and the source was withdrawn from the holder by remote control. The source radiates in all directions and a panoramic exposure was obtained on all anchorages at this level. The source was then lowered to each ring of anchorages in turn and the process repeated. Voids found by radiography on this job were later filled by drilling into the duct and injecting further grout.

---

[1]) Contractors: Taylor Woodrow Construction Ltd., Southall.

[2]) Radiographers: Pantak Ltd., Slough.

It has been the intention of this paper to demonstrate the effectiveness of gamma radiography in showing defects in structural concrete.

There are now commercial radiographers who will carry out examination of concrete in Great Britain and abroad at a charge which is reasonable considering the value of some preformed units and the cost of any repair work which may subsequently have to be carried out in the event of a failure.

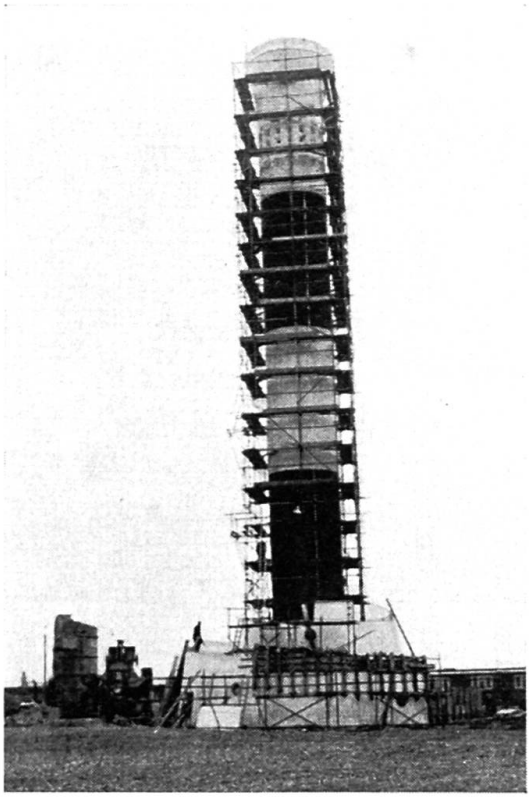

Fig. 8.

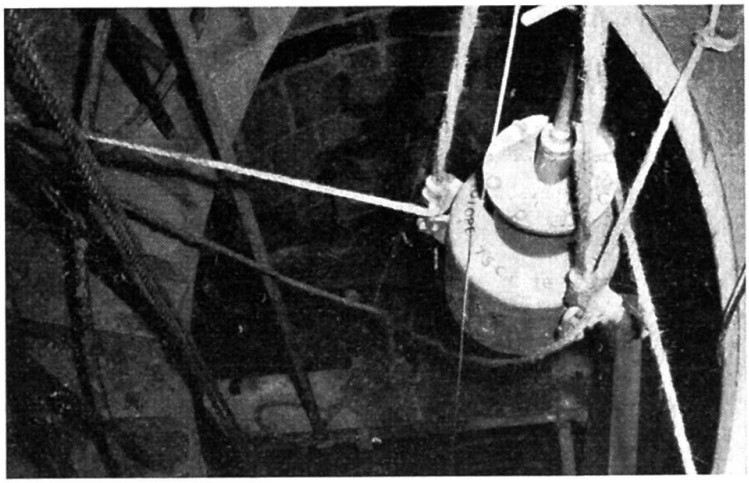

Fig. 9.

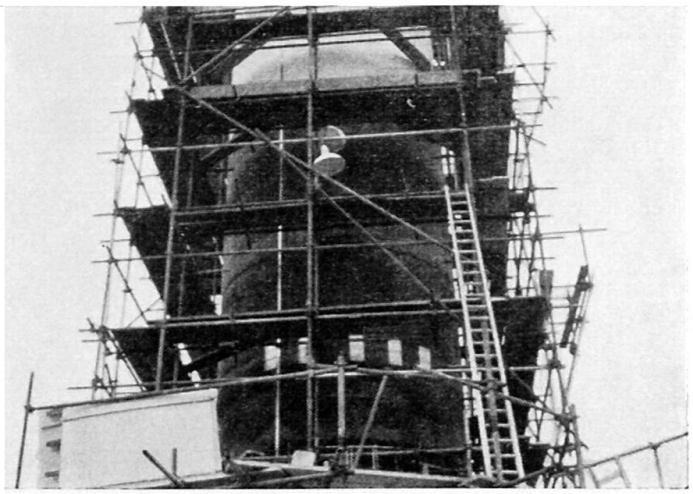

Fig. 10.

References

1. Forrester, J. A. Application of gamma radiography to concrete. The Engineer, Vol. 205, No. 5327, 28th February, 1958, pp. 314—315.
2. Forrester, J. A. The use of gamma radiography to detect faults in grouting, Magazine of Concrete Research, Vol. 11, No. 32, July, 1959, pp. 93—96.

Summary

The use of gamma radiography to study concealed features in structural units is described. Some examples are given of work done on identifying reinforcement, grouting efficiency and efficiencies of compaction of concrete and mortar joints between concrete units.

Résumé

L'auteur décrit l'emploi de la gammagraphie pour l'étude des caractéristiques cachées d'éléments d'ouvrage. Il donne quelques exemples de recherches effectuées pour repérer des armatures et pour observer la qualité des injections et l'efficacité du compactage des joints de mortier ou de béton entre éléments.

Zusammenfassung

Es wird die Anwendung der röntgenographischen Prüfung mit Gammastrahlen als zerstörungsfreies Verfahren zur Feststellung verborgener Eigenschaften von Bauwerksbeton beschrieben. An Hand von Beispielen wird gezeigt, wie mit der Methode die Lage von Armierungseisen festgestellt und verbliebene Hohlräume bei Injektonsarbeiten aufgedeckt wurden.

Leere Seite
Blank page
Page vide