



## جانب الجمعية اللبنانية لتعزيز الشفافية - لا فساد

**الموضوع :** نسخة عن تقرير شركة الاتحاد الهندسي ش.م.ل (خطيب وعلمي) حول  
وضعية أهراءات الحبوب في مرفأ بيروت.

**المرجع :** - تقرير شركة الاتحاد الهندسي ش.م.ل (خطيب وعلمي) رقم  
BY0000/L005/22 تاريخ ٢٠٢٢/٣/٢٤ ومرفقاته.

- كتابكم المسجل لدى المديرية العامة لرئاسة مجلس الوزراء برقم  
٢/١٤١٥ تاريخ ٢٠٢٢/٧/٢٦

إشارة الى الموضوع والمرجع المُبينين أعلاه،  
وبناء على طلبكم،

نودعكم ريباً نسخة عن التقرير الفني لشركة الاتحاد الهندسي ش.م.ل (خطيب وعلمي) حول:  
وضعية أهراءات الحبوب في مرفأ بيروت.

القاضي محمود مكيه

أمين عام مجلس الوزراء

اسم المرسل: سمير الخطيب  
المنصب الحالي:  
نائب الرئيس التنفيذي  
هاتف: 1 843 843 (961)

مبنى خطيب وعلمي،  
جناح، بيروت -لبنان  
هاتف: 844944 / 843843-1(961)  
فاكس: 844400-1(961)  
ص.ب: 14-6203 بيروت  
1105 2100 لبنان



التاريخ: 24، آذار، 2022

Ref: BY0000/L005/22

جانب: دولة رئيس مجلس الوزراء  
الأستاذ نجيب ميقاتي المحترم

المرجع: مرفأ بيروت

الموضوع: إستقرار أهراءات الحبوب في مرفأ بيروت

تحية طيبة وبعد،

إشارة إلى الموضوع أعلاه و بناء لطلبكم بإبداء شركتنا الرأي بمدى إستقرار أهراءات الحبوب في مرفأ بيروت ، فإننا قمنا بتحضير التقرير الفني المرفق الذي يلخص الوضع الحالي للمنشأ والخطوات التقنية المطلوبة في حال تقرر المحافظة على الأهراءات أو إزالتها.

وتفضّلوا بقبول فائق الاحترام،

شركة الاتحاد الهندسي ش.م.ل  
(خطيب وعلمي)

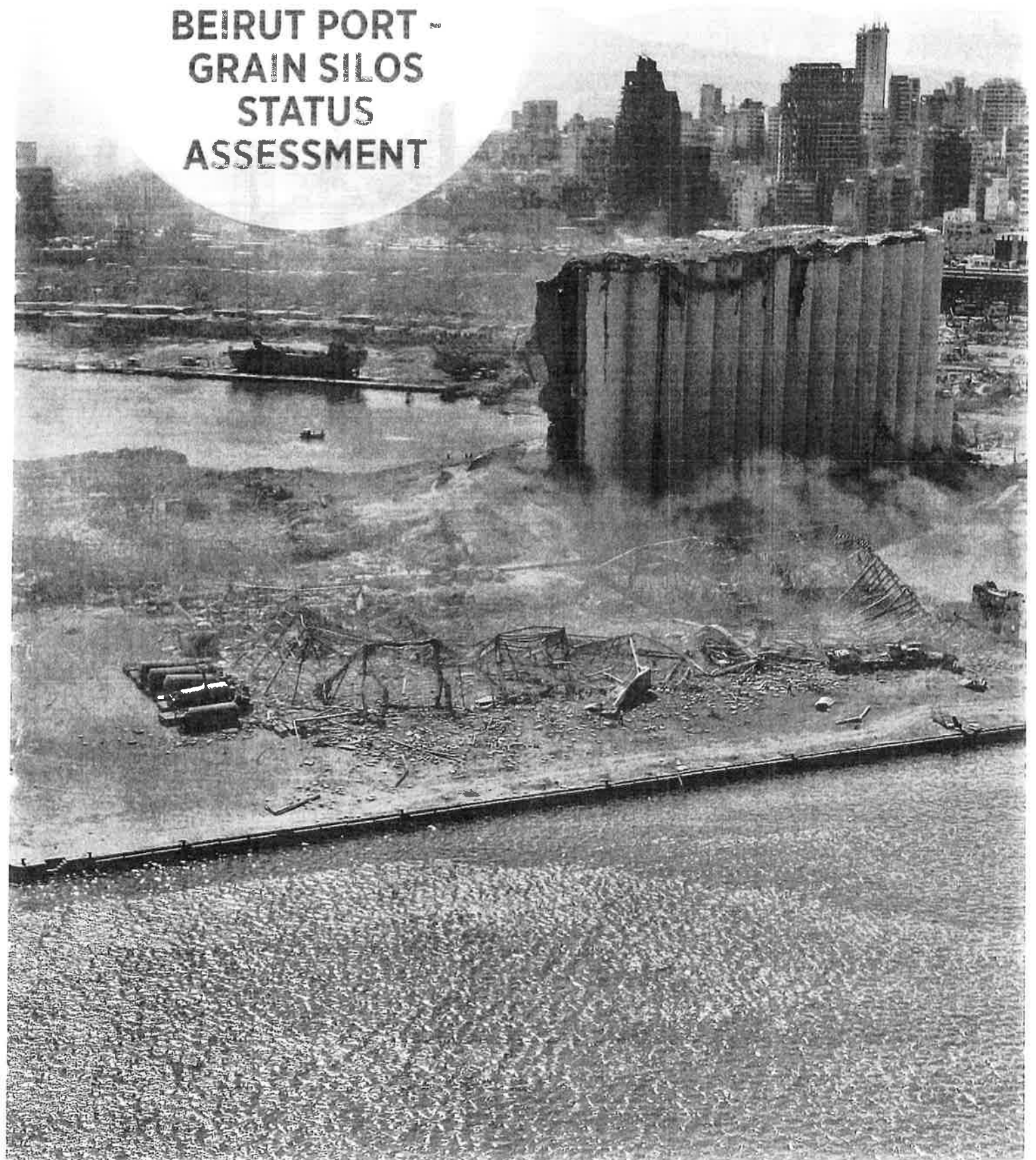
سمير الخطيب  
نائب الرئيس التنفيذي



المرفقات: تقرير فني ملخص



**BEIRUT PORT  
GRAIN SILOS  
STATUS  
ASSESSMENT**



# CONTENT

- 4 Preface
- 4 Introduction
- 5 Collaboration and Inspection  
Activities After the Explosion
- 6 Current Status of the Grain Silos
- 8 K&A Technical Opinion

# List Of Figures And Tables

## List of Figures

Figure 1: Grain Silos Location in Beirut Port Before Explosion (Source: Paper - Beirut Explosion - Structural Assessment of the Explosion Magnitude)

Figure 2: Sketch Showing Damaged Silos (Source: Paper - Beirut Explosion - Structural Assessment of the Explosion Magnitude )

Figure 3: Aerial Photograph Showing the Damage by the Lebanese Air Force (Source: Paper - Beirut Explosion - Structural Assessment of the Explosion Magnitude)

Figure 4: A Front View (Looking to the West) Showing the Damaged Silos

Figure 5: 3D Laser Scan Survey Comparison between September 2020 and March 2022 - red color shows substantial tilting and blue refers to slight movement (Source: Beirut Port Silos - Interim Reporting on Structural Health Monitoring - Graphic Documents and FAQ, Version 3.0 March 7<sup>th</sup>, 2022)

Figure 6: Crater due to the Explosion Next to the Silos

Figure 7: 50m Buffer Around Silos

## List of Tables

Table 1: Participants in Silos Safety Technical Report

## PREFACE

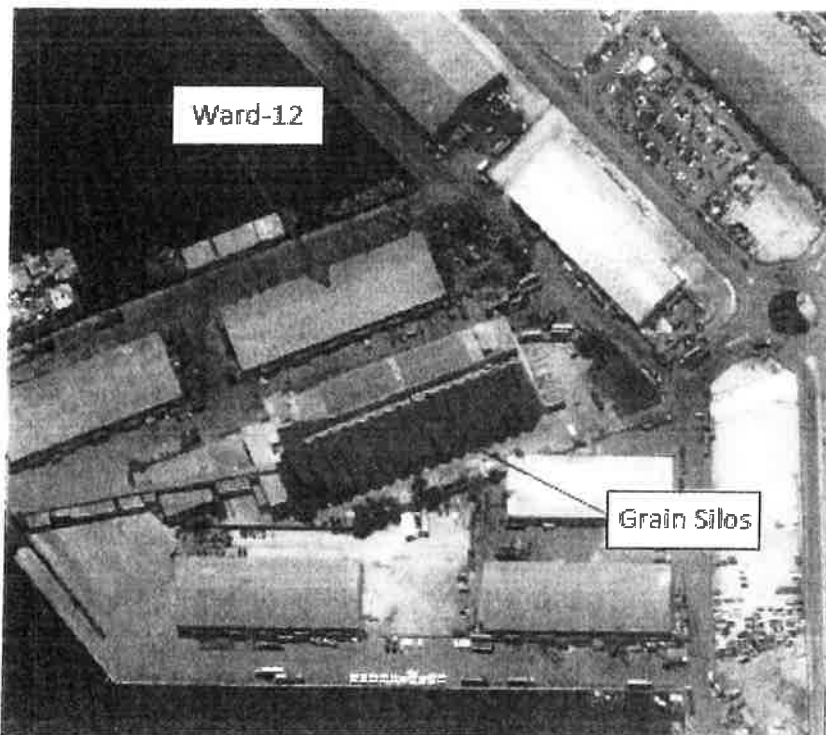
This brief report was prepared upon the request of his Excellency P.M. Najib Mikati for Khatib and Alami (K&A) to provide a technical opinion pertaining to the current status of the damaged grain silos at Beirut Port and whether these structures need to be demolished or can be maintained.

## 1 INTRODUCTION

On the 4<sup>th</sup> of August, 2020, one of the world's biggest explosions destroyed much of Beirut's port and devastated swaths of the capital of Lebanon.

The huge explosion left more than 200 dead, and more than 6,500 injured. Some 300,000 homes were damaged or destroyed.

The deadly explosion in Beirut port significantly damaged the Beirut port silos which are adjacent to the center of the explosion, at around 85m proximity.



*Figure 1 Grain Silos Location in Beirut Port Before Explosion (Source: Pagar Beirut Explosion - Structural Assessment of the Blast Site, Page 104)*

The aim of this report is to present an overview of the different investigations and collaboration activities following the explosion, and K&A's technical opinion regarding the damaged silos which is mainly based on site visits by K&A personnel and bolstered by the surveys and instrumentations made independently by Mr. Durand from AMANN Company.

### 3 CURRENT STATUS OF THE GRAIN SILOS

A significant damage occurred to the grain silos as a result of the explosion. The damage is concentrated at the Eastern part of the Silos and has mainly affected the first and second rows as shown in the series of figures below.

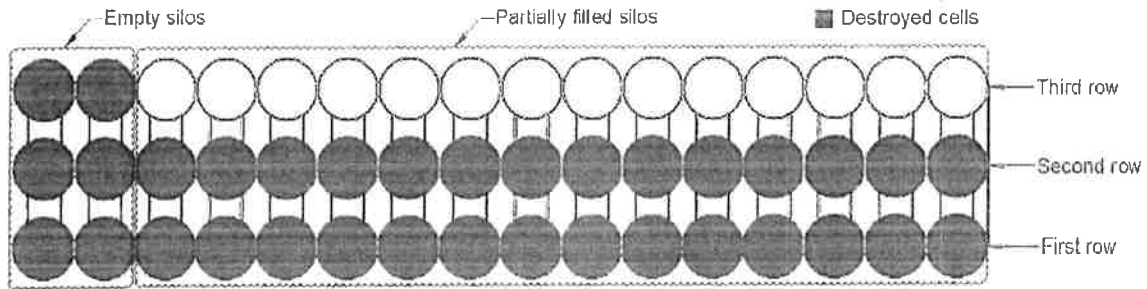


Figure 2. Sketch Showing Damaged Silos (Source: Paper - Beirut Explosion - Structural Assessment of the Explosion Magnitude)

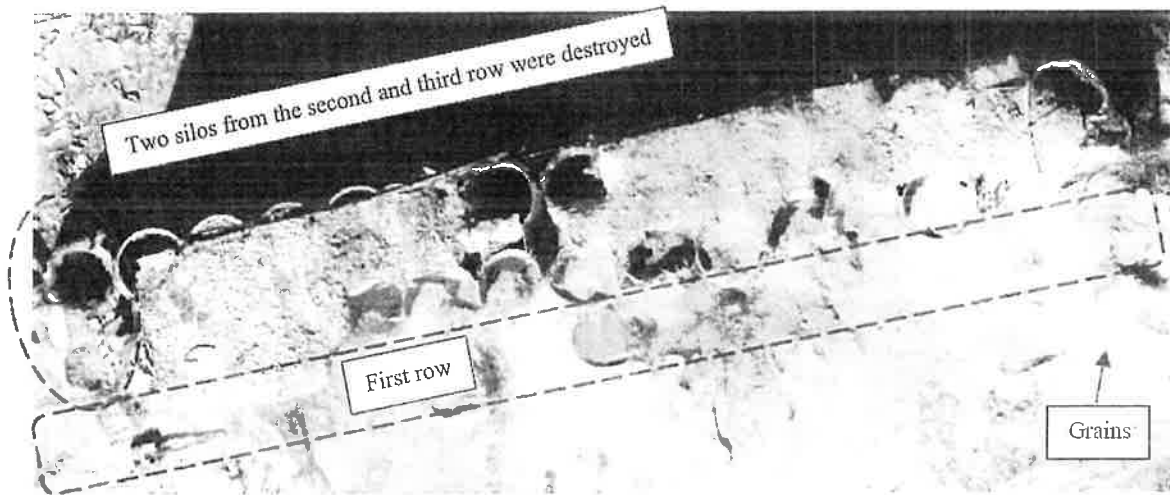


Figure 3. Aerial Photograph Showing the Damage by the Lebanese Air Force (Source: Paper - Beirut Explosion - Structural Assessment of the Explosion Magnitude)



Figure 4. A Front View (Looking to the West) Showing the Damaged Silos

In addition to the collapse of parts of the silos, some concrete slabs and vertical elements / walls remain loosely hanging by reinforcing bars to the remaining elements and they are prone to collapse anytime which necessitates the implementation of a safe buffer zone to protect people in the area against potential unfortunate accidents. This safe buffer zone has already been recommended by KA experts.

In terms of silos movement and tilting, the continuous monitoring done by AMANN's Mr. Emmanuel Durand indicated the following:

- The Northern part of the silos is moving continuously while the Southern part appears stable.
- After the explosion the silos moved and tilted west, by approximately 250-300mm at the top.
- For the last few months, the northern block was tilting back slowly to the east back to the vertical position. This movement was superposed on daily fluctuations due to thermal exposure. As per the latest readings (inclinometers and laser scanning) made by Mr. Durand the silos continue to tilt eastward at a rate of 1mm/day.

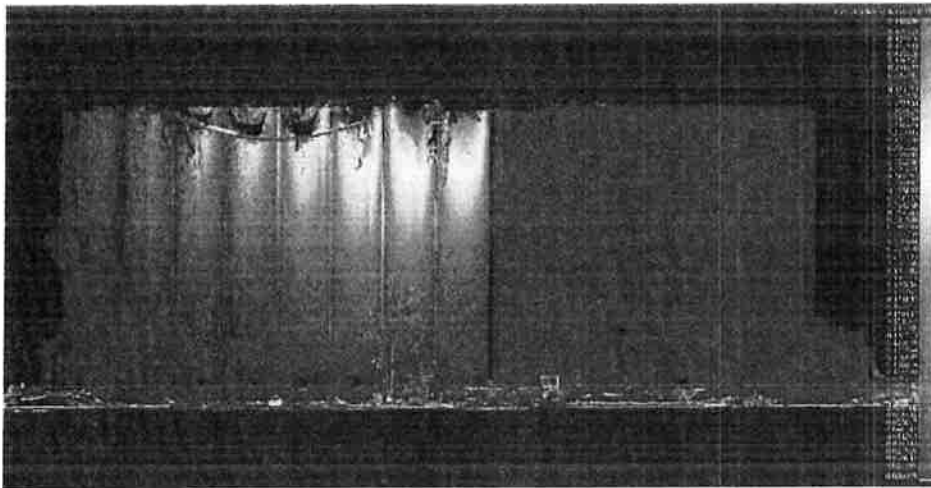


Figure 5: 3D Laser Scan Survey Comparison between September 2020 and March 2022 - red color shows substantial tilting and blue refers to slight movement (Source: Beirut Port Silos - Interim Reporting on Structural Health Monitoring - Graphic Documents and FAQs, Version 3.0, March 7<sup>th</sup>, 2022).

Regarding the foundations of the silos, the extent of damage at this time can only be inferred from engineering calculations and from the observed movement of the northern silos block. It is expected that many of the precast piles have failed in shear and lost connection with the foundation raft. In addition, a large crater was created next to the silos which has probably affected/weakened the underlying soil conditions.

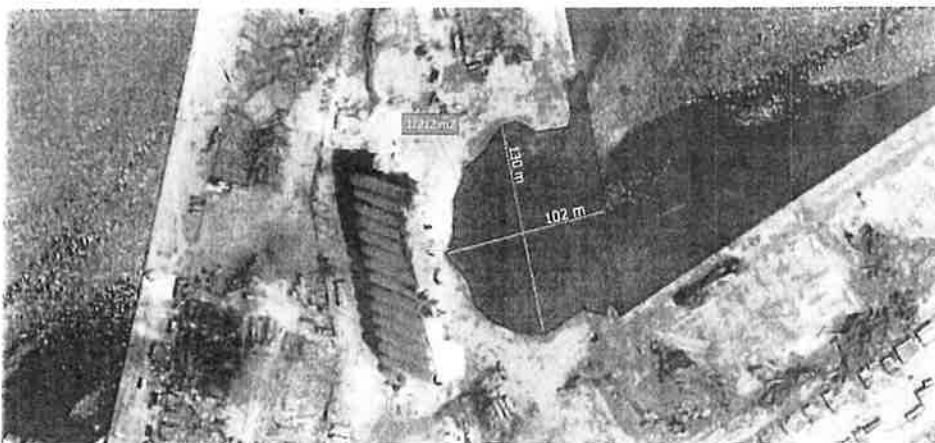


Figure 6: Large Crater Generated due to the Explosion next to the Silos

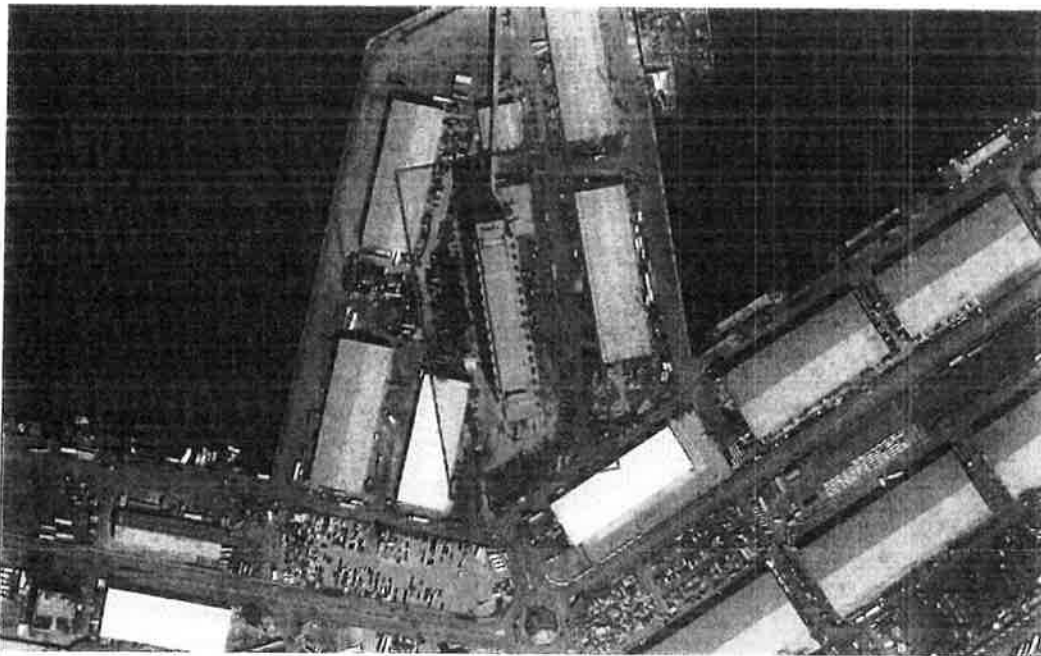
Confirmation of the foundations damage would require extensive instrumented inspections and investigations.



## 4 K&A TECHNICAL OPINION

Based on our assessment and the information and data made available to K&A by Mr. Durand (AMANN Company), there appears to be no imminent danger of overall collapse of the silos. But there is always the danger that some concrete slabs loosely hanging by reinforcing bars could fall off and cause localized damage where they impact the ground below.

The silos can be considered dangerous to approach. A safety distance of some 50m should be maintained around the silos footprint should a decision be made to keep the silos in place.



*Figure 7 50m Buffer Around Silos*

K&A was requested by the Ministry of Economy and the CDR back in 2021 to assist in the preparation of a methodology for silos demolition if this decision will be taken by the relevant Authorities. Accordingly, K&A has assisted in the preparation of two draft demolition RFPs, one based on conventional means only and one allowing the use of explosives for controlled implosion.

In case the remaining part of the silos structure is to be kept in place permanently, then one must protect against possible future collapse either as a result of earthquakes or further deterioration of the foundations. The following engineering measures will need to be taken:

- A. Removal of all loose hanging concrete slabs, walls and debris.
- B. Extensive remote-sensing investigation, geophysical and geotechnical surveys, and testing of the foundations condition including laboratory testing on concrete and steel.
- C. Possible reinforcement of the structure and its existing foundations through measures which will be defined later based on the outcome of the detailed analysis.
- D. Installation of continuous displacement monitoring system.

Even then, it might be preferable to keep the public at the safety distance from the structure or within reinforced path-ways at ground level or at some elevation.

