Okinawa Infrastructure Tourism Training

Course Content

- Infrastructure Conditions in Okinawa Prefecture (Bridges)
- Oroku Road Construction Project Overview
- Regarding Unexploded Ordnance Disposal in Okinawa

Date: Friday, November 14, 2024

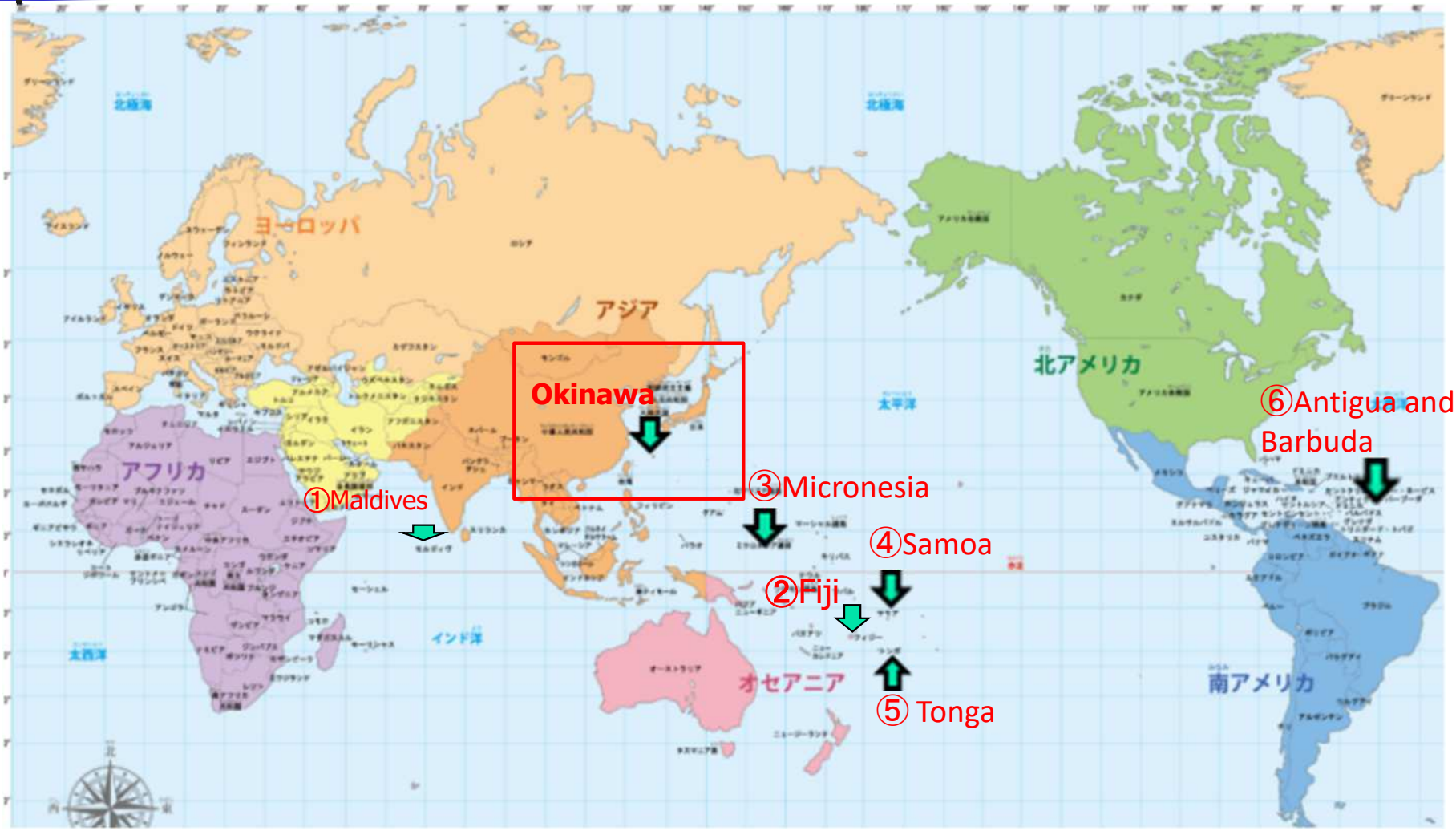
JICA Okinawa/Oroku Road Construction Site

Hiroshi Oyadomari,SK Design Co.

Position of Okinawa with the Countries of the Trainees

①Maldives・・・・・・・・・・・・・・・・・Indian Ocean
②Fiji・・・・・・・・・・・・・・・・・・・South Pacific
③Micronesia ・・・・・・・・・・・・・・・South Pacific
④Samoa・・・・・・・・・・・・・・・・・・South Pacific
⑤ Tonga ・・・・・・・・・・・・・・・・・・South Pacific
⑥Antigua and Barbuda・・・Atlantic Ocean
（Caribbean Sea）

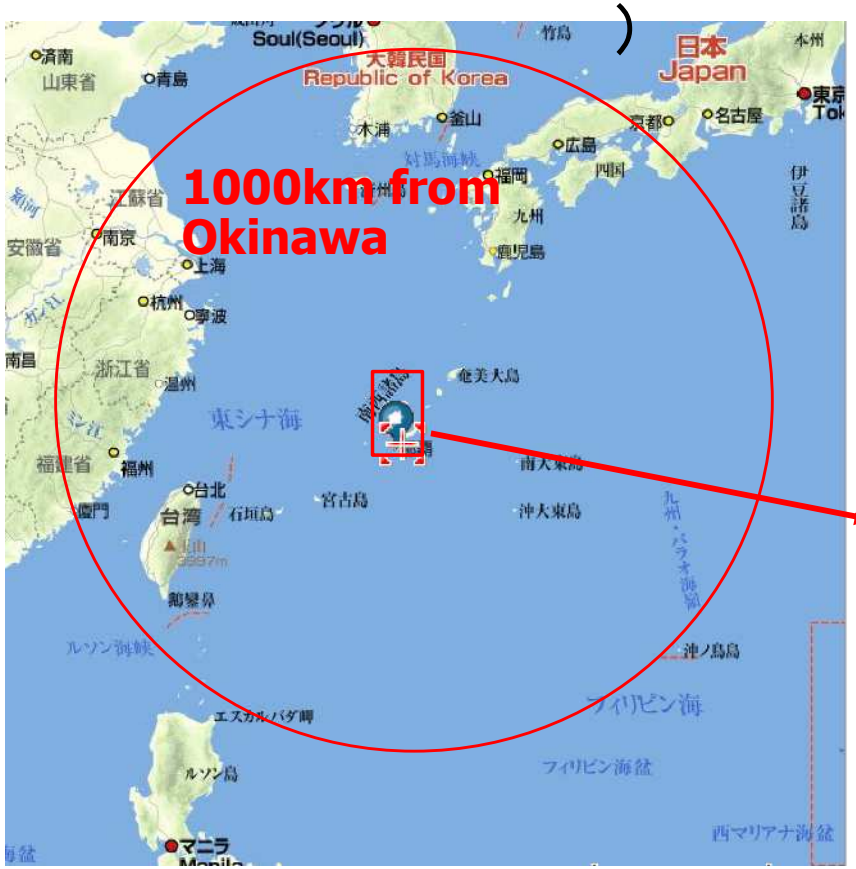
Trainee Countries



Location of Okinawa

Location of Okinawa

Okinawa Island　（Total length:120km）



- **About 800 km to Fukuoka, South Korea, Shanghai and TaiwanAbout 1500 km to Tokyo, Manila and Beijing**

Infrastructure situation in Okinawa Prefecture

Okinawa Prefecture was devastated in World War II (Pacific War: 1941~1945).

After that, it was under American rule and returned to Japan in 1972, but infrastructure development was lagging behind that of the mainland.

Road development has been planned and constructed as a pillar of infrastructure development as a policy to catch up with the development of social infrastructure on a par with the mainland in accordance with the Okinawa Promotion Special Measures Law (Note) for Okinawa's infrastructure. Among the infrastructure development, many roads (bridges, etc.) have been built around it.

Note: The Act on Special Measures for the Promotion of Okinawa is a regional development law in which the national government takes special support measures from the perspective of "balanced development of the national land" for regions that need to support self-sustaining development due to given constraints.

Management of Roads in Okinawa Prefecture

FY 2019

Road Facilities Status Report

As of 1,April,2019

Okinawa Prefectural Government,
Department of Civil Engineering and Construction,
Road Management Division

Prefectural total　Road Status Summary Table (current + old roads)

道			
	計	1, 077, 120	1, 005, 819	93. 4
市　町　村　道		6, 561, 725	4, 264, 864	65. 0
Total length		8, 196, 135	5, 823, 857	71. 1

Total road length in Okinawa: 8196 km

Breakdown

- Expressway：　57km（1%）
- National Highways：　500km（6%）
- Prefectural Road：　1077km（13%）
- Municipality Road：　6562km(80%)

Breakdown of the number of bridges in Okinawa Prefecture

① National Highway	:	３８４
② Expressway company	:	１０２
③ Okinawa Prefecture	:	６６６
④ Municipalities	:	２１０１
Grand total	:	３２５３

Source: FY2020 (Status of measures for aging bridges in Okinawa Prefecture: Okinawa General Bureau)

Life-Extending Repair Plan for Bridges in Okinawa Prefecture

4. Life-Extending Repair Plan

Based on the basic policy, we have developed a life-extending repair plan for bridges. Based on this plan, we will continue to inspect, maintain, and repair bridges, as well as replace them. The maintenance and management costs for the next 50 years under the newly formulated plan were estimated as shown in Figure 9. In the future, we will accumulate data on the results of repairs and inspections, and analyze the difference between the plan and the actual situation to improve the accuracy of the plan, which will be reviewed as necessary.

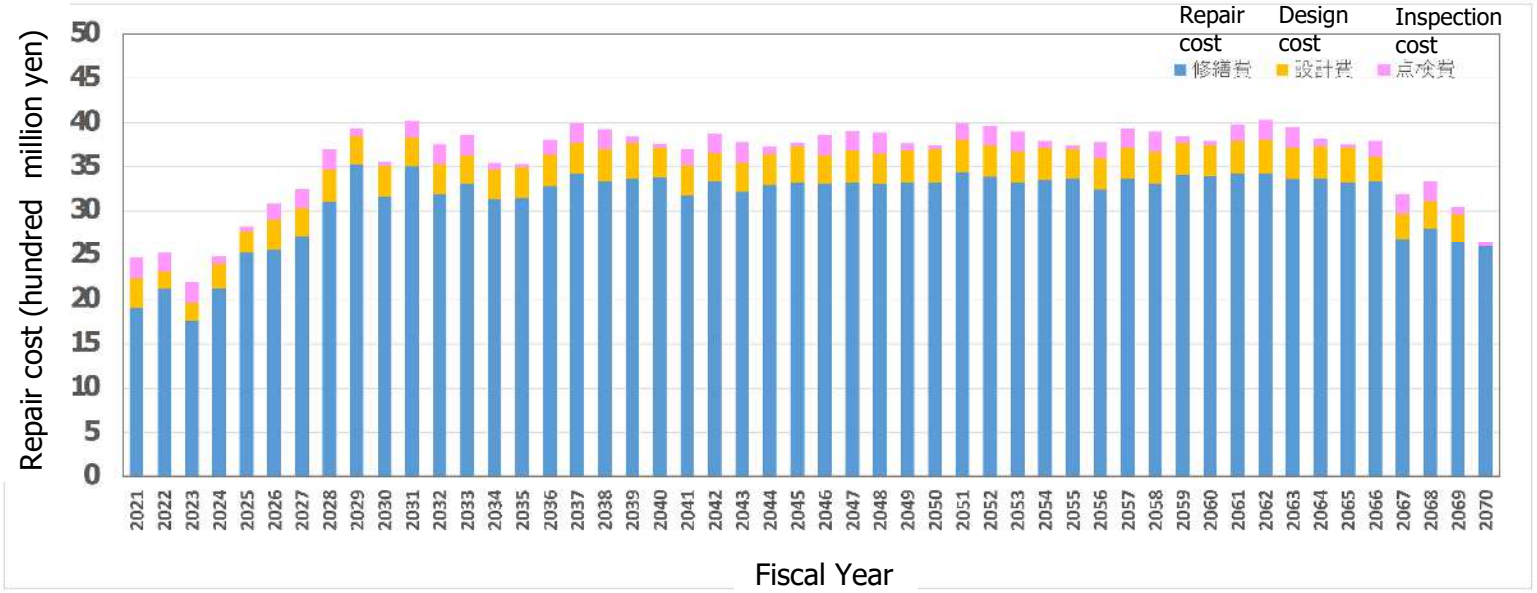


Fig. 9: Maintenance and management costs over the next 50 years

Life-Extending Repair Plan for Bridges in Okinawa Prefecture

5. Effects of Life-Extending Repair Plan

By implementing the life-extending repair plan, a cost reduction (48% reduction) of approximately 138 billion yen (approximately 2.8 billion yen/year) in maintenance and management costs is expected over the next 50 years compared to the conventional management method. (Fig. 10)

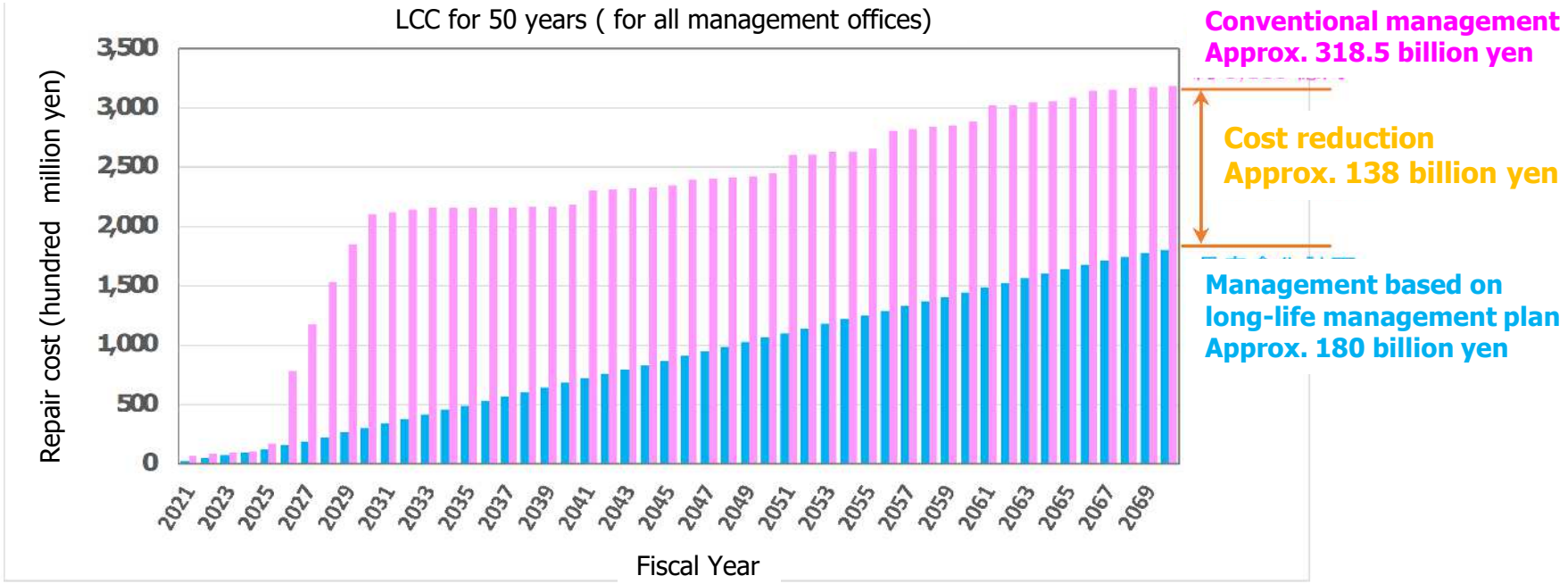


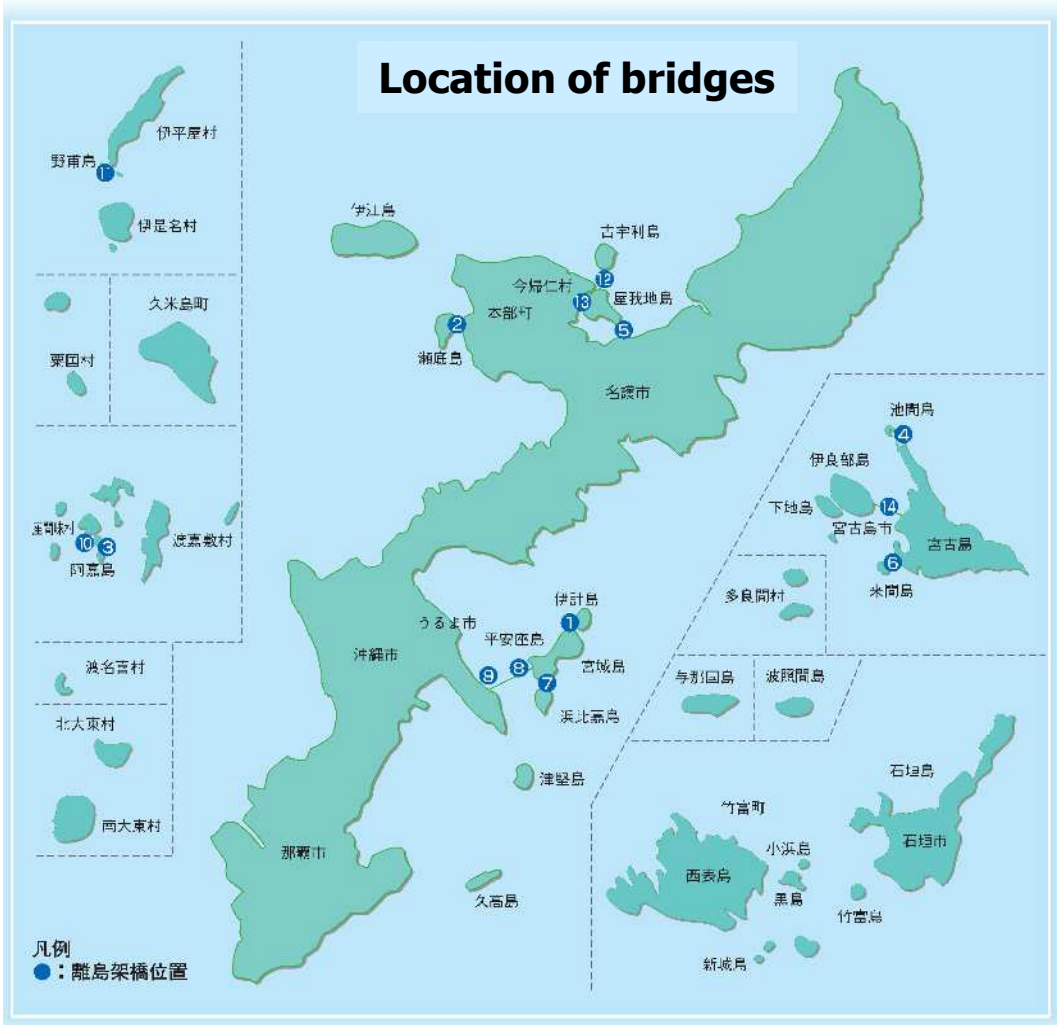
Fig. 10 Cost Reduction Effects of Life-Extending Repair Plan

Bridge Maintenance & Management Policy of Okinawa Prefecture

Based on the current situation in Okinawa Prefecture, the following policy will be used to maintain and manage bridges.

1. Promote a shift from conventional symptomatic maintenance management to preventive maintenance management
2. Implement maintenance and management in a precise manner that takes into account the characteristics of Okinawa Prefecture.
3. Reduce maintenance and management costs by lowering life cycle costs (LCC).
4. Promote maintenance and repair through budget leveling

Major Bridges in Okinawa



1. Ikei Bridge
2. Sesoko Bridge
3. Geruma Bridge
4. Ikema Bridge
5. Yagaji Bridge
6. Kurima Bridge
7. Hamahiga Bridge
8. Yoake Bridge
9. Henza Mid-sea Bridge
10. Aka Bridge
11. Noho Bridge
12. Kouri Bridge
13. Warumi Bridge
14. Irabu Bridge

■ **Source: Okinawa Prefecture Remote Island Bridges 2016（Roads and Streets Construction Division, Department of Civil Engineering and Construction, Okinawa Prefecture)**

Major Bridges in Okinawa

Sesoko Bridge ②

- **Source: Okinawa Prefecture Remote Island Bridges 2016（Roads and Streets Construction Division, Department of Civil Engineering and Construction, Okinawa Prefecture)**

Major Bridges in Okinawa

Ikema Bridge

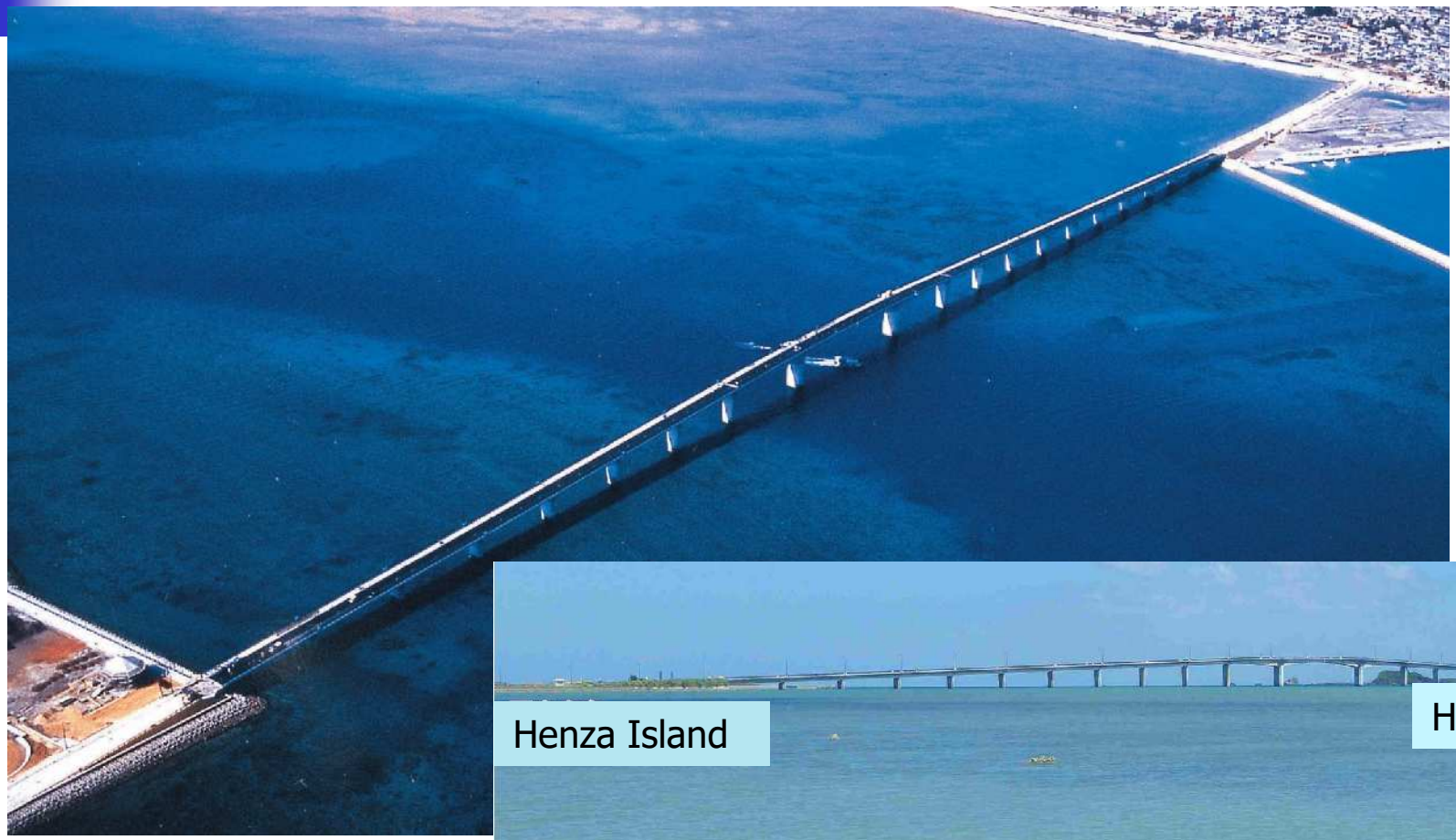
■ **Source: Okinawa Prefecture Remote Island Bridges 2016（Roads and Streets Construction Division, Department of Civil Engineering and Construction, Okinawa Prefecture)**

Major Bridges in Okinawa

Kurima Bridge ⑥

■ **Source: Okinawa Prefecture Remote Island Bridges 2016（Roads and Streets Construction Division, Department of Civil Engineering and Construction, Okinawa Prefecture)**

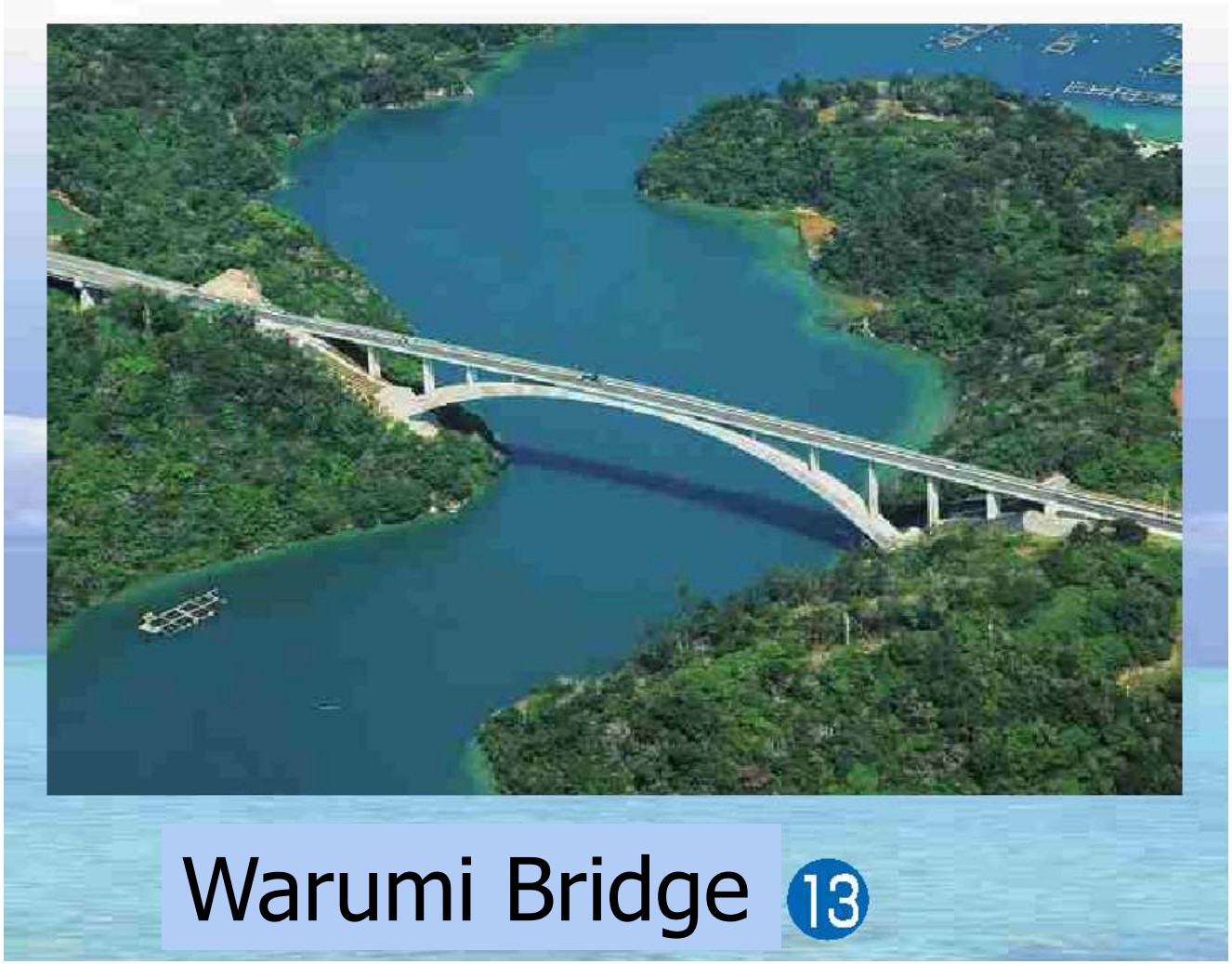
Major bridges in Okinawa



Hamahiga Bridge ⑦ Side

- **Source: Okinawa Prefecture Remote Island Bridges 2016（Roads and Streets Construction Division, Department of Civil Engineering and Construction, Okinawa Prefecture)**

Major Bridges in Okinawa



■ **Source: Okinawa Prefecture Remote Island Bridges 2016（Roads and Streets Construction Division, Department of Civil Engineering and Construction, Okinawa Prefecture)**

Major Bridges in Okinawa

■ **Source: Okinawa Prefecture Remote Island Bridges 2016（Roads and Streets Construction Division, Department of Civil Engineering and Construction, Okinawa Prefecture)**

Major bridges in Okinawa

Southern Gate Bridge(Ishigaki City)

Major bridges in Okinawa

- Monorail track girder･Steel column

Oroku Road Site visit

■場　所：南部国道事務所管内小禄地区

Oroku Road (Overview)

高規格幹線道路 那覇空港自動車道

Oroku Road(Overview)

那覇空港自動車道

一般国道５０６号　小禄道路

１．概　　要

沖縄自動車道、南風原道路、豊見城東道路と一体となって本島北部及び中南部から那覇空港間の定時性、高速性を確保するとともに都市部の交通混雑の緩和を図ることを目的とする道路です。

○事　業　区　間　：沖縄県那覇市鏡水～豊見城市名嘉地

○延　　長　：５．７ｋｍ

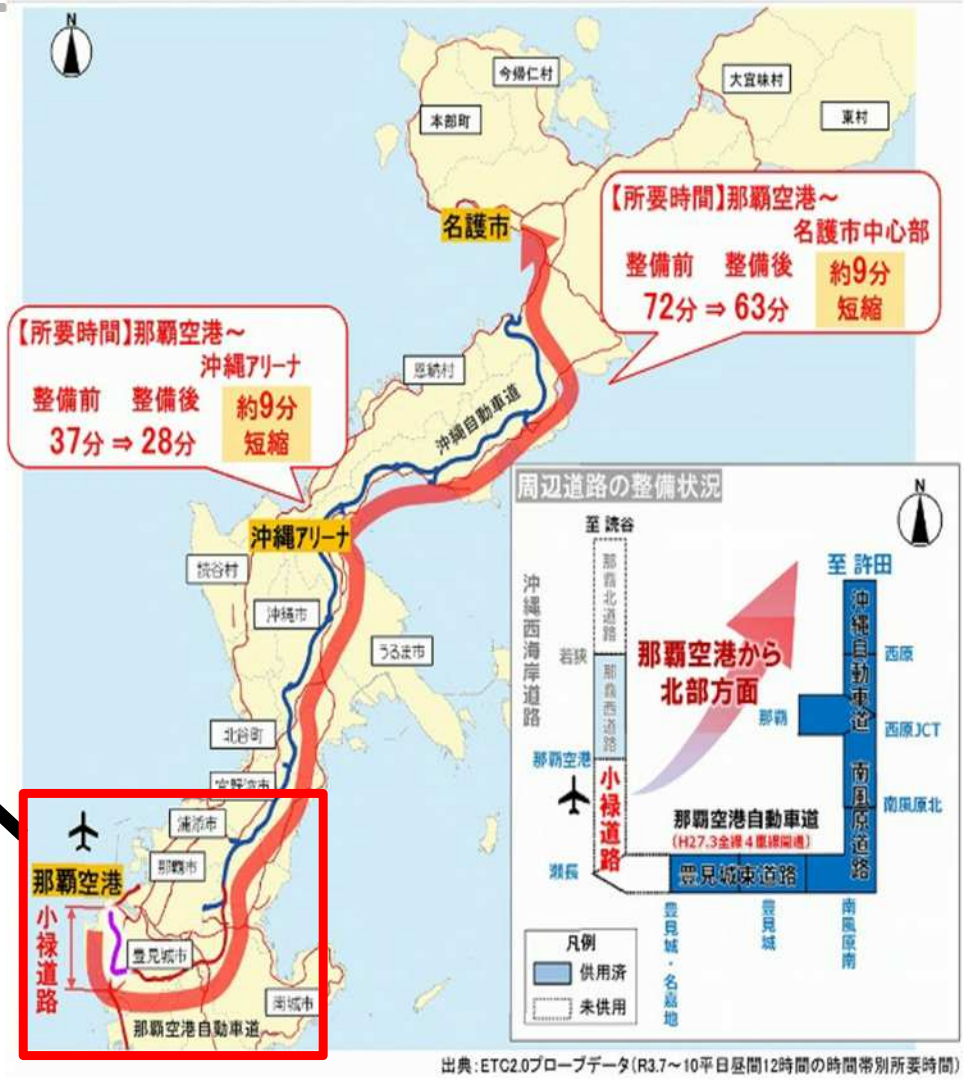
○Ｒ　５　当　初　：１０８．０億円

２．令和５年度事業内容

○那覇市鏡水～豊見城市名嘉地（延長５．７ｋｍ）

・調査設計、用地補償、橋梁上下部工、改良工

Oroku Road(Overview)

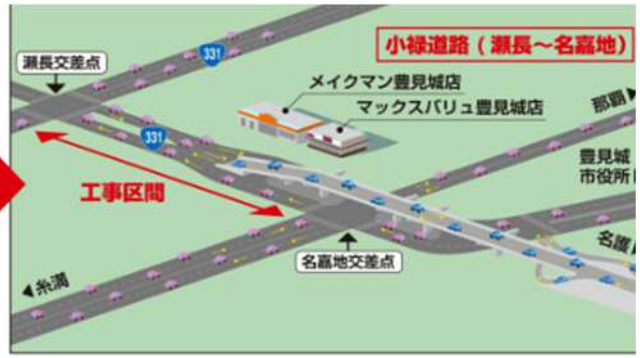


Oroku Road(Overview)

Oroku Road(Overview)

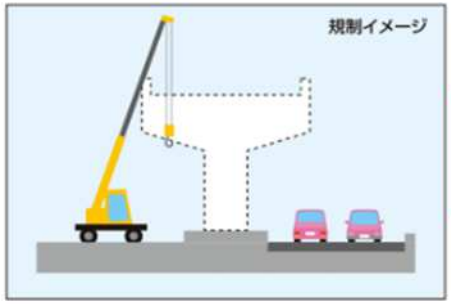
Before construction

国道331号　　：4車線
那覇空港自動車道：2車線



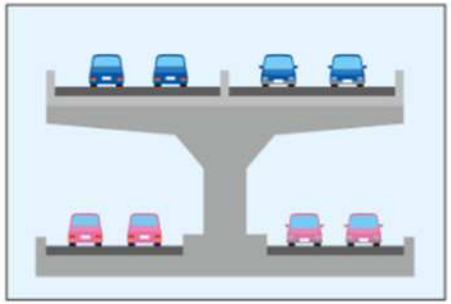
Regulated

【昼　間】国道331号　　：4車線
　　那覇空港自動車道：0車線
【夜　間】国道331号　　：2車線
　　那覇空港自動車道：0車線



Completion

国道331号　　：4車線
那覇空港自動車道：4車線



Oroku Road(Overview)

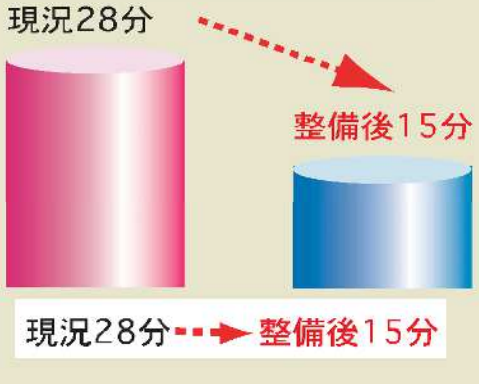
Relief of traffic congestion

With the development of the Oroku Road, it is expected that the travel speed on the Oroku Bypass will be improved by about 23 km/h from the current level, and traffic congestion will be alleviated.

国道331号沿道に立地する商業施設

effect Ensuring punctuality and speed

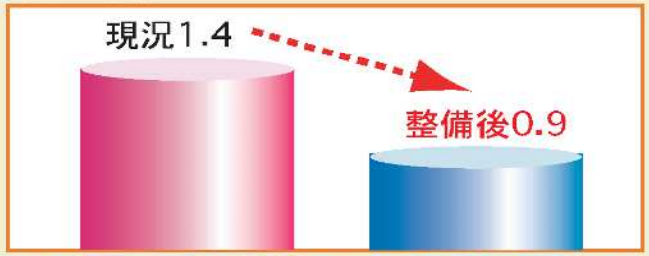
小禄道路の整備により、那覇空港から沖縄自動車道（西原JCT）までの高速ネットワークが形成され、沖縄県の玄関口である那覇空港への定時性・速達性が向上。



Oroku Road(Overview)

effect Ensuring traffic volume in the Oroku area

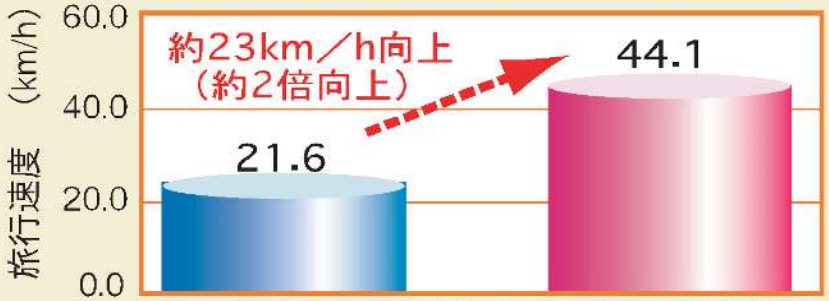
小禄道路の整備により、国道331号小禄地区における交通容量を確保。



【国道331号　那覇市具志地先における混雑度】

effect Change in travel speed

小禄バイパス（小禄道路並行区間（国道331号））における旅行速度の変化



現況（H17）※1　将来（H42）（小禄道路整備時）

※1現況（H17）H17道路交通センサスより算出

effect Reducing through traffic in central Naha

沖縄自動車道、南風原（はえばる）道路、豊見城東（とみしろひがし）道路等と一体となって環状道路を形成することにより、本島中北部から南部間の通過交通が転換。

【那覇中心部を通過する交通の割合】

現況69％ ---► 整備後28％

effect Impact on society as a whole

■環境

並行区間の沿道環境の改善：
5,476t－CO_2／年削減、Nox17.5t／年削減
SPM1.7t／年削減

■地域社会

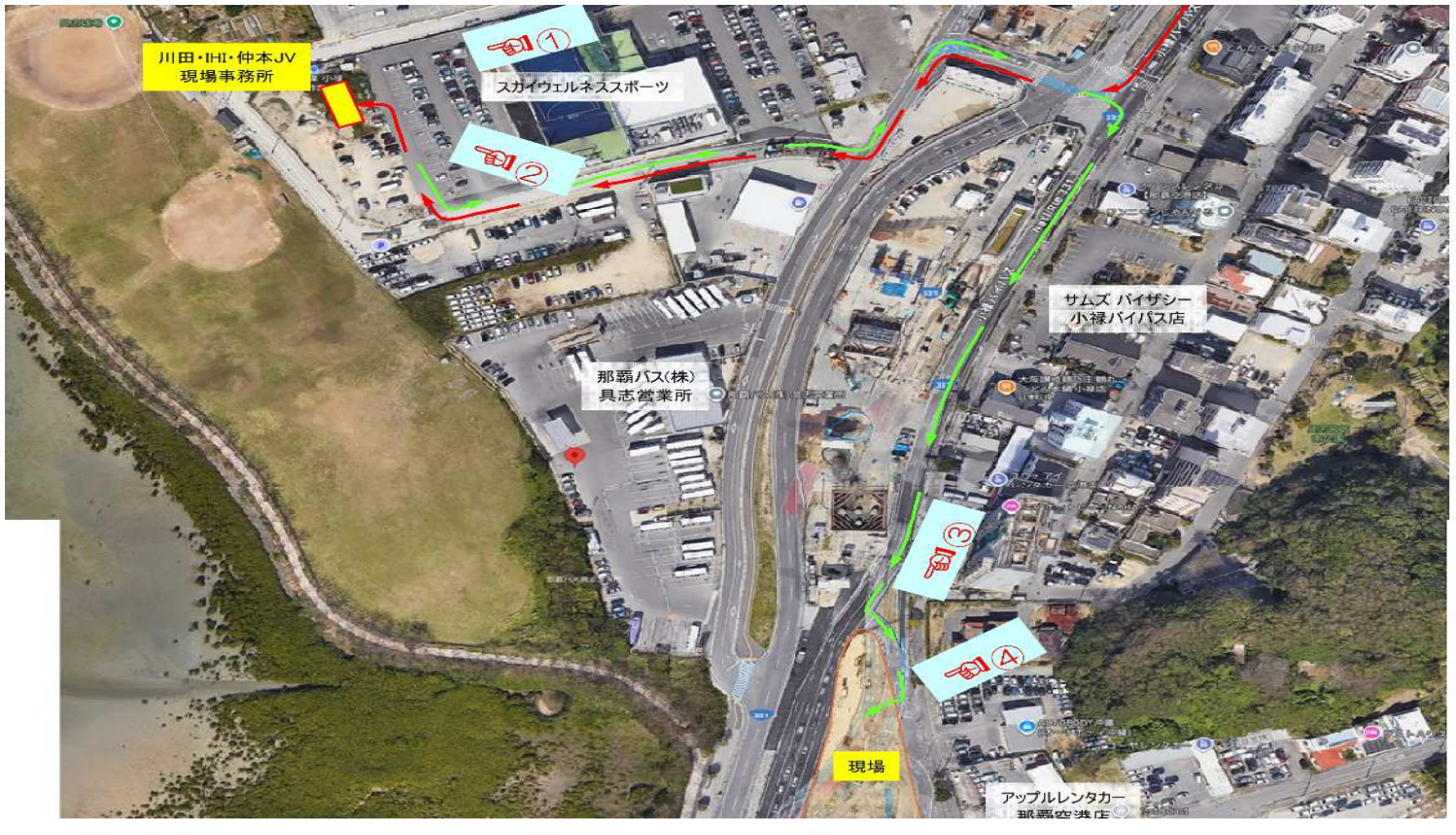
・救急医療施設へのアクセスが向上するとともに、患者への負担軽減が計られる。
・那覇空港までのアクセスが向上し、物流の効率化につながる。

Oroku Road Construction Site Access Route

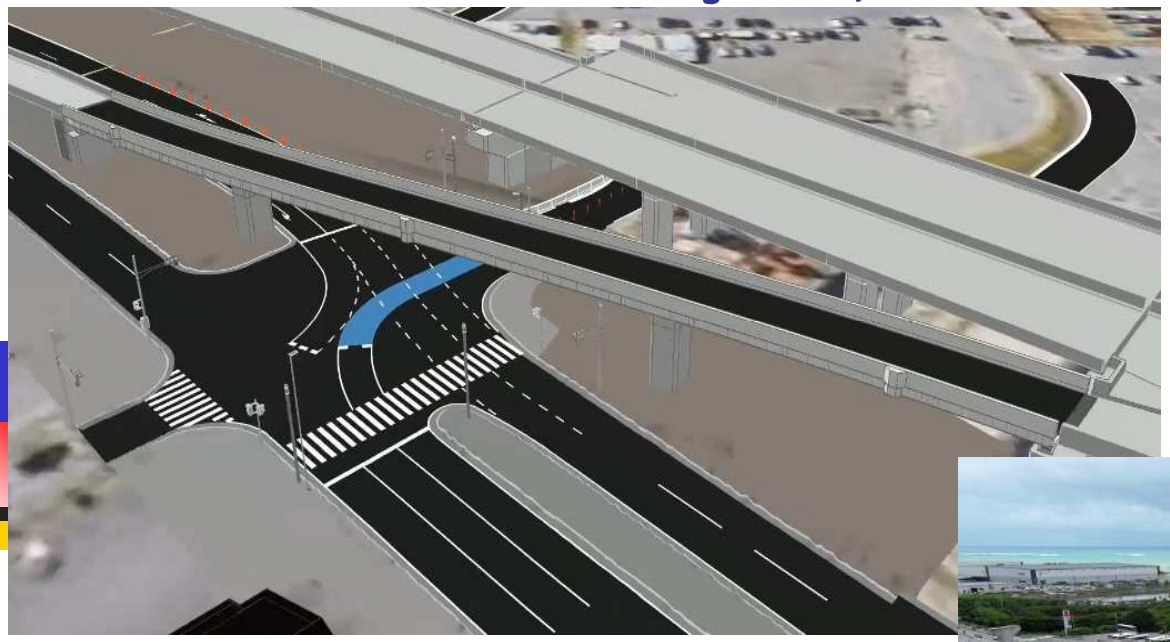
工事現場は以下の3箇所に案内します。

① OFFランプ橋梁上部　② 橋梁上部（P15～P19）

③ 橋梁上部（P19～P24）



Oroku Road Bridge Off-Ramp Superstructure Construction Project, Fiscal Year 2023



完成予想図

現状写真

日本鉄塔工業株式会社

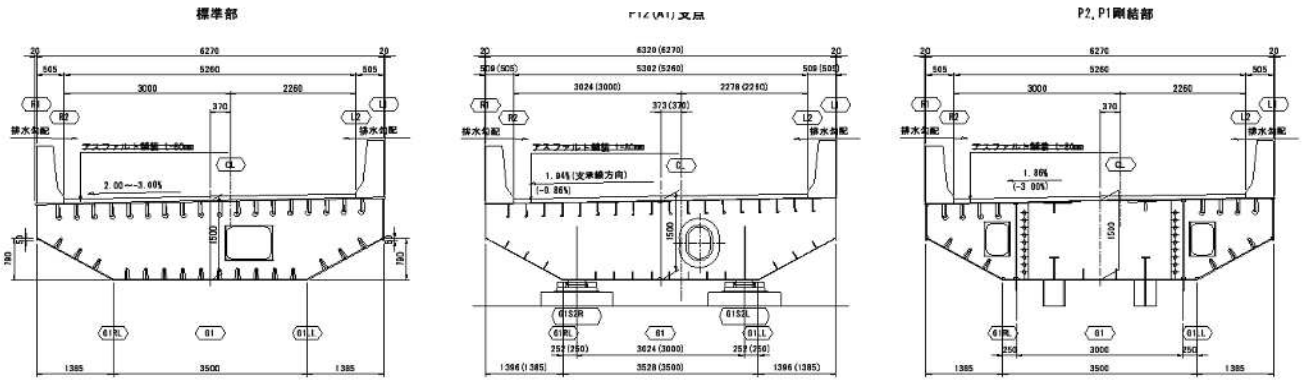
ProjectOverview

This project involves the construction of an off-ramp bridge on the Oroku Road Viaduct section.The construction site is located in a densely populated area surrounding Naha Airport, the Japan Air Self-Defense Force base, commercial facilities, hotels, condominiums, and residential homes.

Construction Details

Project Name: FY2023 Oroku Road Bridge Off-Ramp Superstructure ConstructionLocation: Kushiji, Naha City, Okinawa PrefectureConstruction Period: March 6, 2024 to September 4, 2025 (Scheduled to be extended until January 31, 2026)Scope of Work: Fabrication, transportation, erection, welding, painting, accessories, and RC piers for steel bridge superstructure (Total bridge weight = 306.2 tons)Bridge Type: Steel three-span continuous steel box girder bridge (Piers: Rigid structure) Bridge Length: 109mField Joints: Field welding and high-strength bolted connectionsErection Method: P1 and P2-P12...Crane-bent method A1-P1 and P1-P2...Cantilever erection and large-block vertical transfer/single-lift erection (using 550-ton crane)

cross section



防錆ボルト

StructureExplanation

This project features a rigid structure for the bridge piers (integrating the steel superstructure with the reinforced concrete piers).Generally, movable bearings are more common. In this project, the bridge abutments utilize movable bearings, while the piers employ a rigid structure.

Advantages include:① Supports can be omitted (eliminating high costs and maintenance)② Improved seismic resistance③ Reduced noise and vibration

Disadvantages include:① Installation accuracy management is highly challenging.② Concrete and reinforcing steel work is involved, which superstructure contractors are not adept at.

Erection Method Description

Initial Construction Plan

On-site assembly within the work yard → Multi-axle bogie transport → Bulk erection using large cranes

Background of the Change in Construction Method

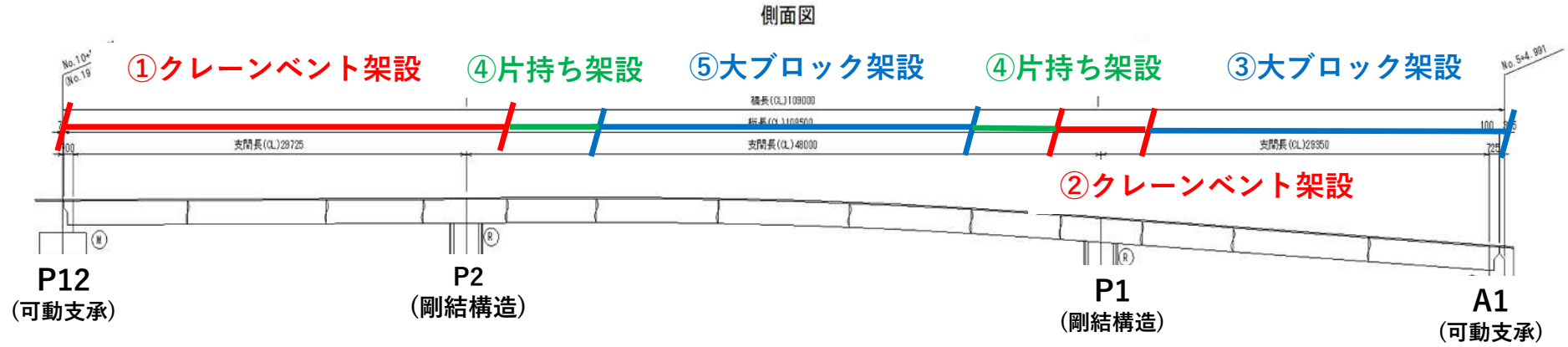
The adjacent work section (Oroku Superstructure, P19-P24) also involved erection work using a multi-axle dolly. As this was a critical process within the entire Oroku Road Project, close coordination was essential.Following coordination, it was discovered that the multi-axle dolly would be used during the same period. Consequently, consideration was given to changing the construction method for the OFF Ramp Bridge to one not requiring the multi-axle dolly.　Proceeding with the erection method review, it was agreed to perform ground assembly on the existing PC bridge and then perform longitudinal launching.As a result of this change, the working yard beneath the girders could be used more extensively, and construction has progressed smoothly between contractors without major issues.

Erection Method Description

Change Design Plan

← 至 那覇空港

至 瀬長交差点 →



Installation Flow

Installation of longitudinal transport equipment on existing PC bridgeand assembly of ground erection platform (partial)

→

Assembling steel girders on the existing PC bridge deck

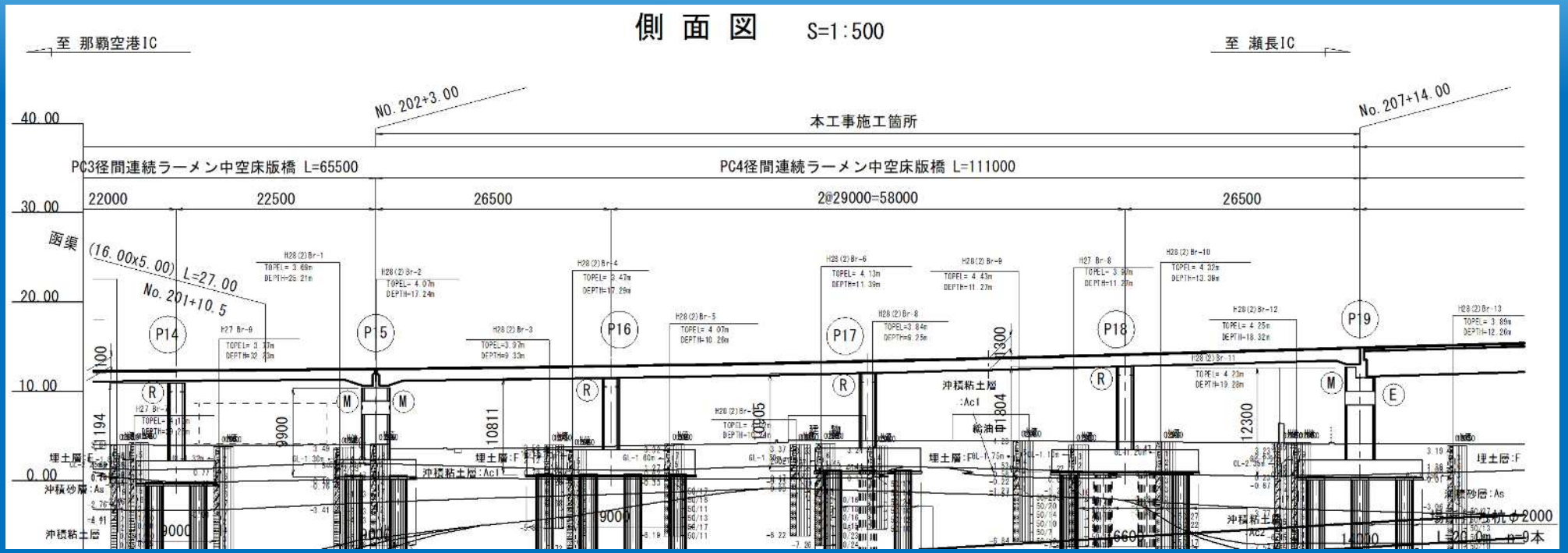
Oroku Road Bridge Superstructure (P15–P19) Construction

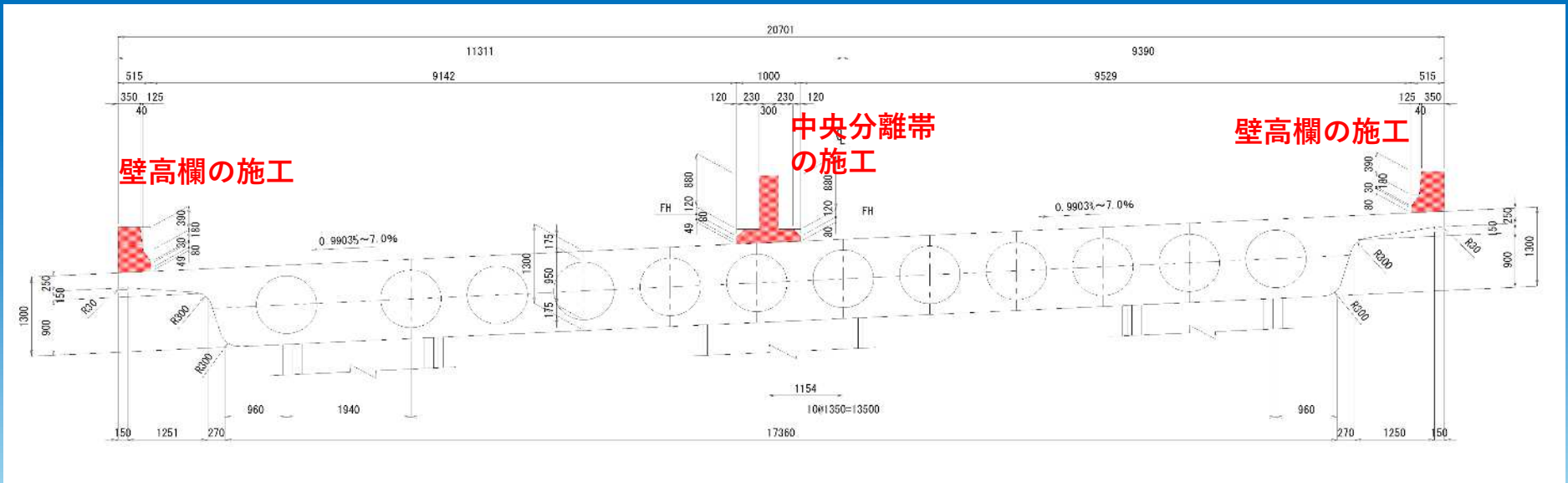
On-site Explanatory Materials

Project Name: FY2023 Oroku Road Bridge Superstructure (P15–P19) ConstructionContracting Authority: Cabinet Office, Okinawa General Affairs Bureau, Southern National Highway OfficeContractor: Kawada Construction Co., Ltd. and Tobishima Corporation Specific Construction Joint VentureConstruction Period: April 4, 2024 – October 29, 2025Contract Amount: ¥1,051,347,000 (Including Consumption Tax: ¥95,577,000) (Revision No. 3)

Construction DetailsAs part of the National Route 331 Improvement Project, this work involves constructing new superstructure for the bridge spanning spans P15 to P19 on the Oroku Road. CProject OverviewBridge Type: Post-tensioned PC4 continuous rigid-frame hollow deck bridgeBridge Length: 111.0m　Overall Width: 18.988m to 21.460mConstruction Method: Primary/Secondary Construction: Column-type falsework + wedge-joint falsework Tertiary/Quaternary Construction: Wedge-joint falseworkAnchoring Method: Fresnay method

General Overview Diagram





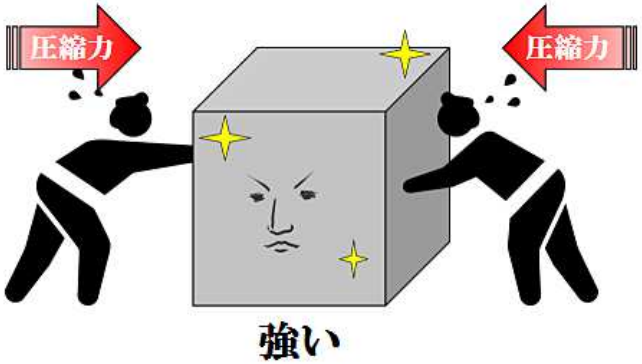
Construction Progress Status

37

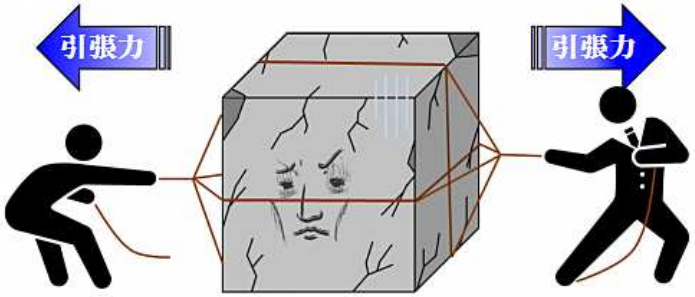
■コンクリートの性質

コンクリートは圧縮には強いものの、引張り強度が極端に小さいという欠点があります。

そこで、コンクリートに荷重が作用する前にコンクリート部材に圧縮力がかかった状態にすること（緊張させること）により、鉄筋コンクリートに比べ、強度・耐久性に優れた部材とすることができます。



強い

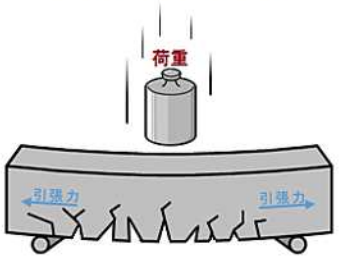


弱い

■無筋コンクリート

無筋コンクリートは引張力に対して非常に弱く、引張強度は圧縮強度の1/10程度と極端に小さいため、大きな引張力が作用した場合、破壊されてしまいます。

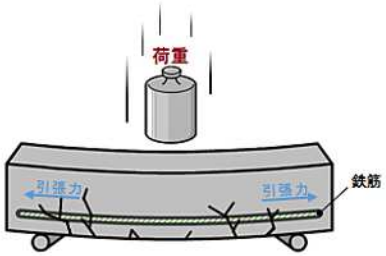
無筋コンクリートの場合



■鉄筋コンクリート

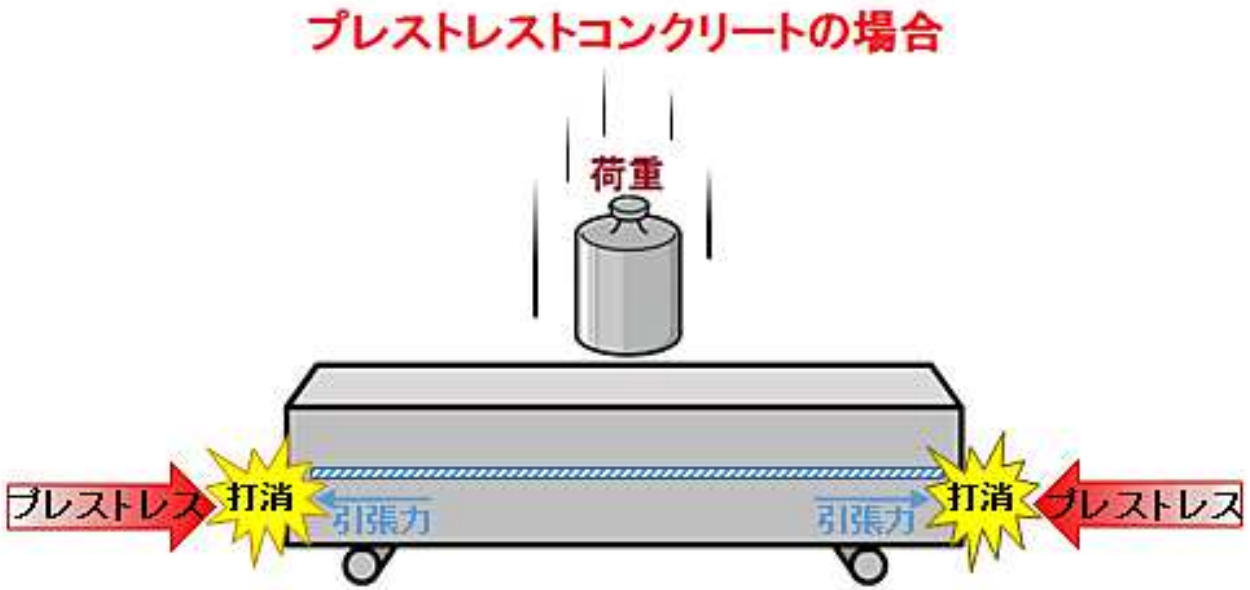
鉄筋コンクリートは引張力に対して鉄筋で抵抗する構造で、無筋コンクリートよりは強くなりますが、コンクリートへのひび割れの発生を完全に防ぐことはできません。

鉄筋コンクリートの場合



■プレストレスト・コンクリート

プレストレストコンクリートとは、荷重によってコンクリートに生ずる引張応力を打ち消す目的で、圧縮応力(プレストレス)をあらかじめコンクリートに人工的に加えることによって、ひび割れを防止し、従来のコンクリート構造よりも、強度・耐久性に優れ、長寿命化を図った構造材料です。

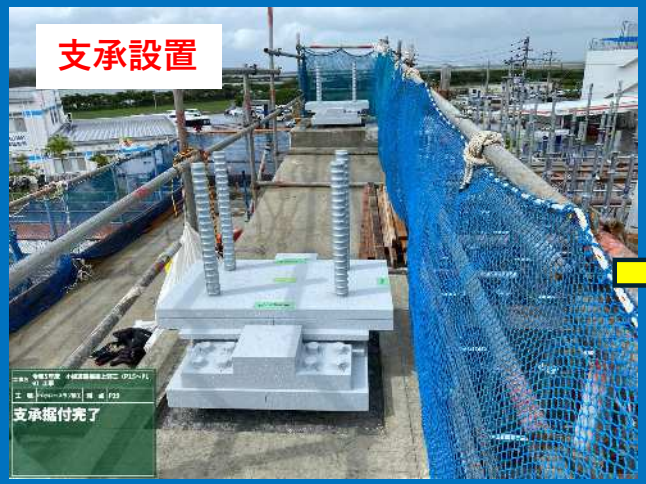


39

Construction Flow for Oroku Road Bridge Superstructure (P15 to P19) (No. 1)

40

Construction Flow for Oroku Road Bridge Superstructure (P15 to P19) (No. 2)



41

Construction Flow for Oroku Road Bridge Superstructure (P15 to P19) (No. 3)

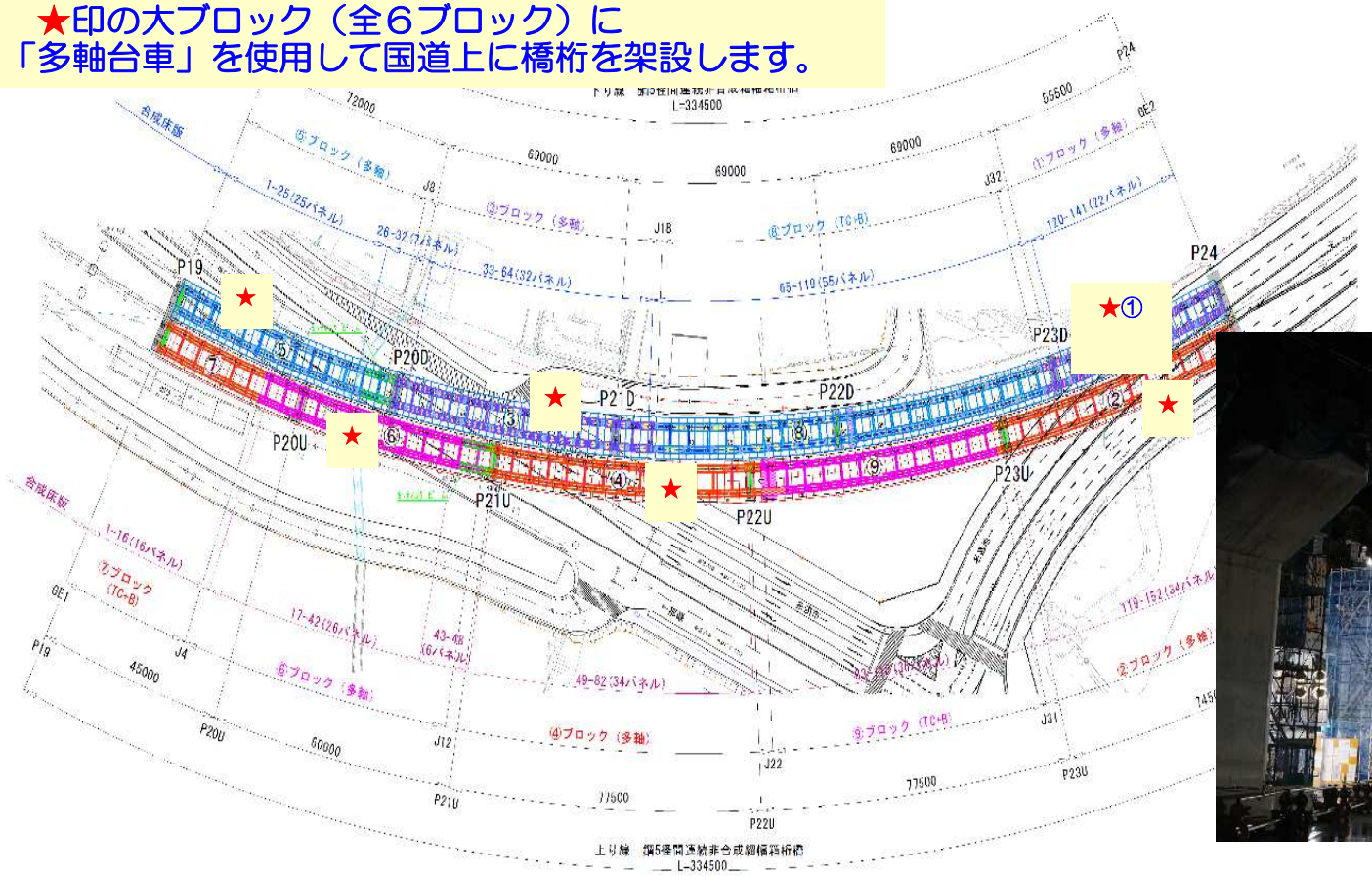
Fiscal Year 2023 Oroku Road Bridge Superstructure Construction Project (Pages 19-24)

JV KAWADA IHI NAKAMOTO

Contracting Authority : Cabinet Office, Okinawa General Affairs Bureau, Southern National Highway Office Contractor : Kawada Industries, IHI, Nakamoto Industries Specific Construction Joint Venture (JV Ratio 44:36:20) Construction Site: Kushiji, Naha City, Okinawa Prefecture ~ Senaga, Tomigusuku City, Okinawa Prefecture Overall Contract Period: September 29, 2023 ~ September 30, 2026 (Subject to Change) Contract Amount (Tax Included): (Initial Contract) ¥5,736,093,000 (First Amendment Contract) ¥6,274,873,000On-site Construction Period: On-site commencement date: July 8, 2024On-site completion scheduled date: End of May 2027Route Name: National Route 506 Naha Airport Expressway Oroku Road Installation Method: Truck Crane Bending + Multi-Axle Carriage Bulk Installation【Bridge Overview】Bridge Type: Steel 5-Span Continuous Non-Composite Narrow-Flange Box Girder Bridge (Twin Span)Bridge Length: 334.5m (Upbound Lane) 334.5m (Downbound Lane) Span Lengths: 45.0m + 60.0m + 77.5m + 77.5m + 74.5m (Upbound Lane) 72.0m + 69.0m + 69.0m + 69.0m + 55.5m (Downbound Lane) Total Width: 11.15m (Upbound Line)Total Steel Weight: 2,223.9tBridge Area: 71,492㎡Other: Steel Piers 3 (324.4t)

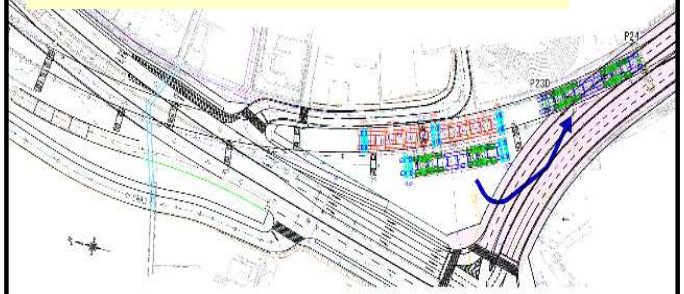
【Construction Overview】　This project involves transporting factory-fabricated steel box girders to the site and installing them atop completed bridge piers.　On-site, the girders will be erected sequentially in nine separate blocks.　The girders spanning National Route 331 are assembled by welding components within the on-site yard.The largest block measures 85m in length, 11m in width, and weighs a massive 400 tons.This large block is loaded onto a “multi-axle transporter” for movement along the national highway, where the girder is then positioned into place.

〔ブロック割り図〕
★印の大ブロック（全６ブロック）に
「多軸台車」を使用して国道上に橋桁を架設します。

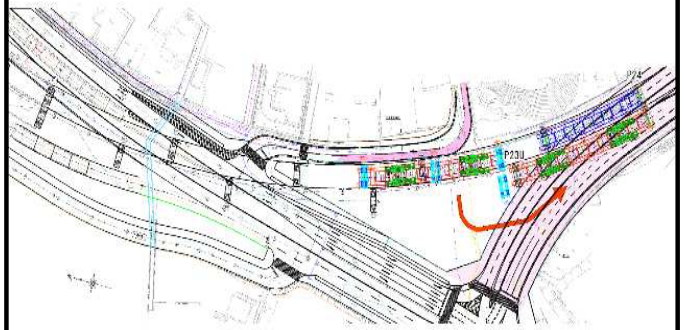


架設施工STEP図

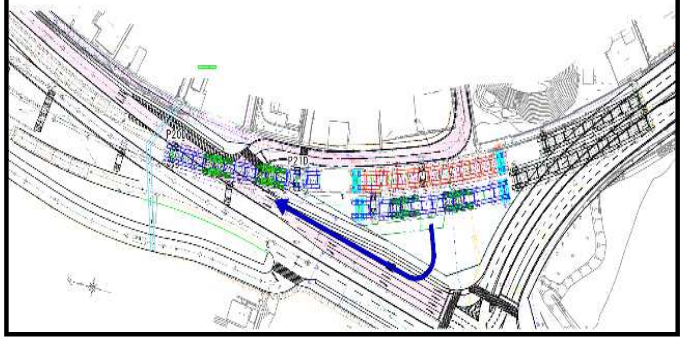
①ブロック　多軸台車一括架設



②ブロック　多軸台車一括架設

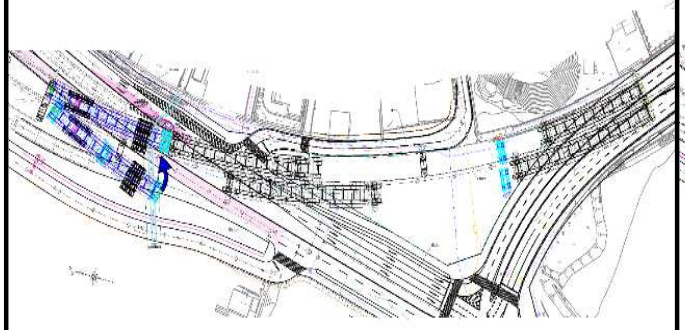


③ブロック　多軸台車一括架設

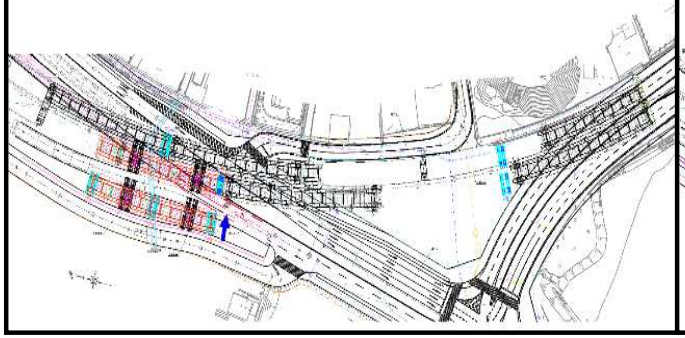


④ブロック　多軸台車一括架設

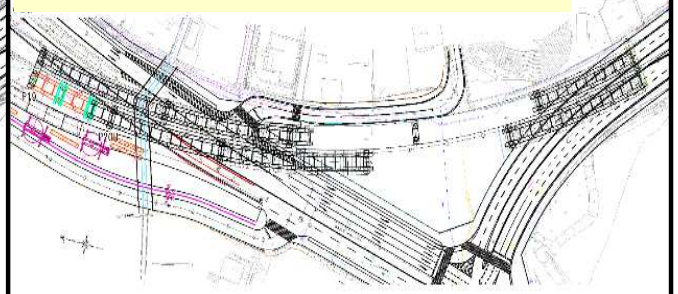
⑤ブロック　多軸台車一括架設



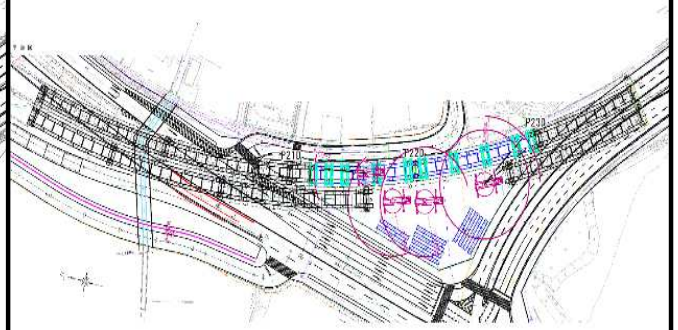
⑥ブロック　多軸台車一括架設



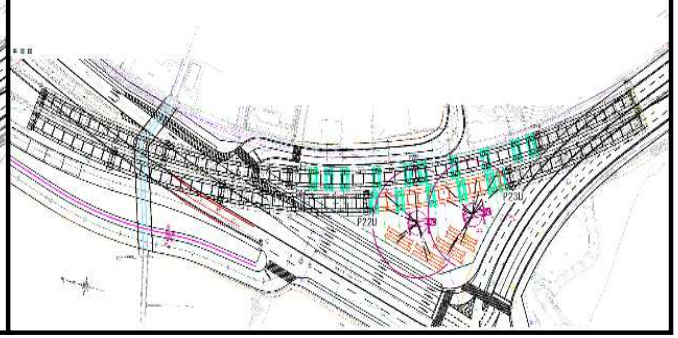
⑦ブロック　ﾄﾗｯｸｸﾚｰﾝ+ﾍﾞﾝﾄ架設



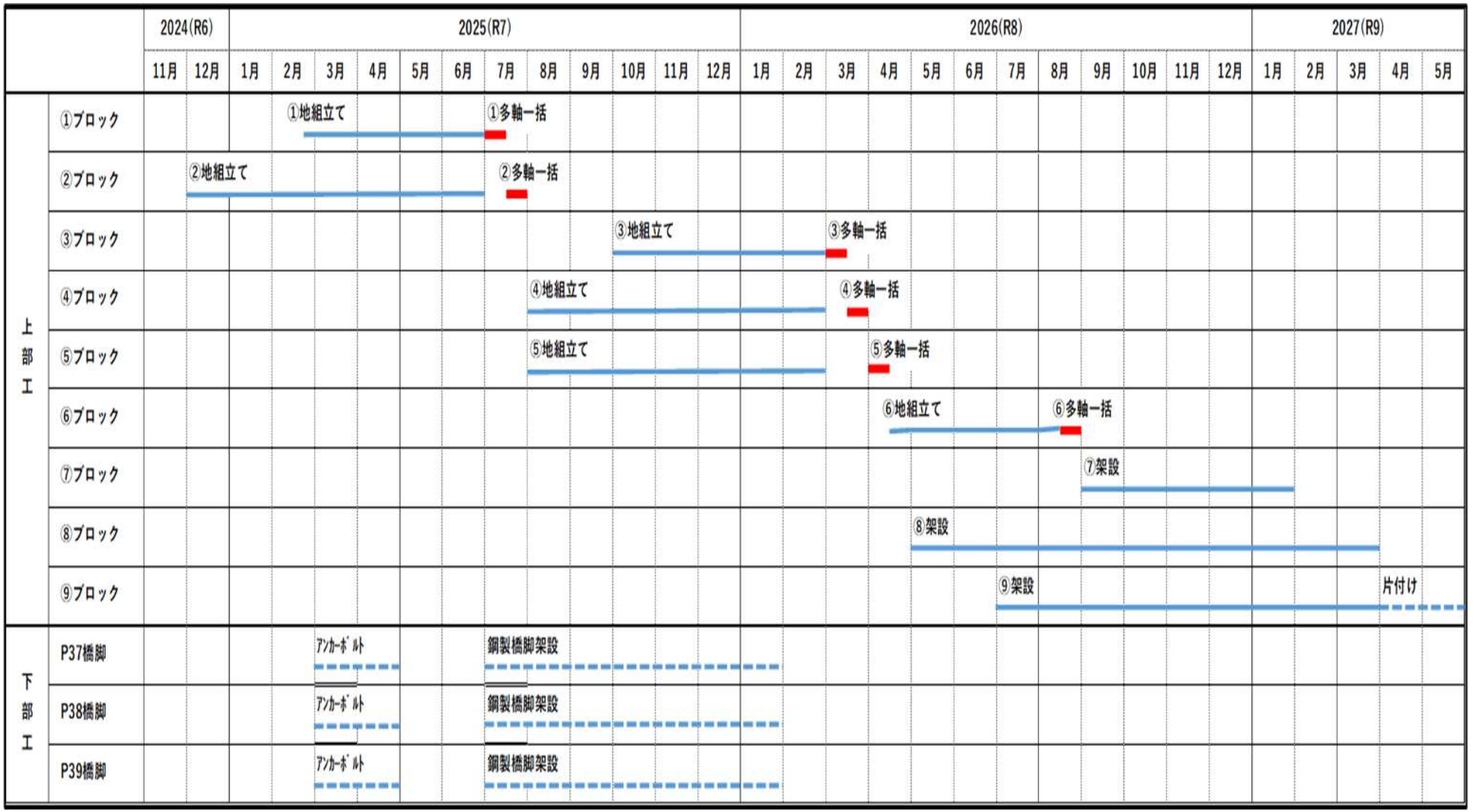
⑧ブロック　ﾄﾗｯｸｸﾚｰﾝ+ﾍﾞﾝﾄ架設



⑨ブロック　ﾄﾗｯｸｸﾚｰﾝ+ﾍﾞﾝﾄ架設



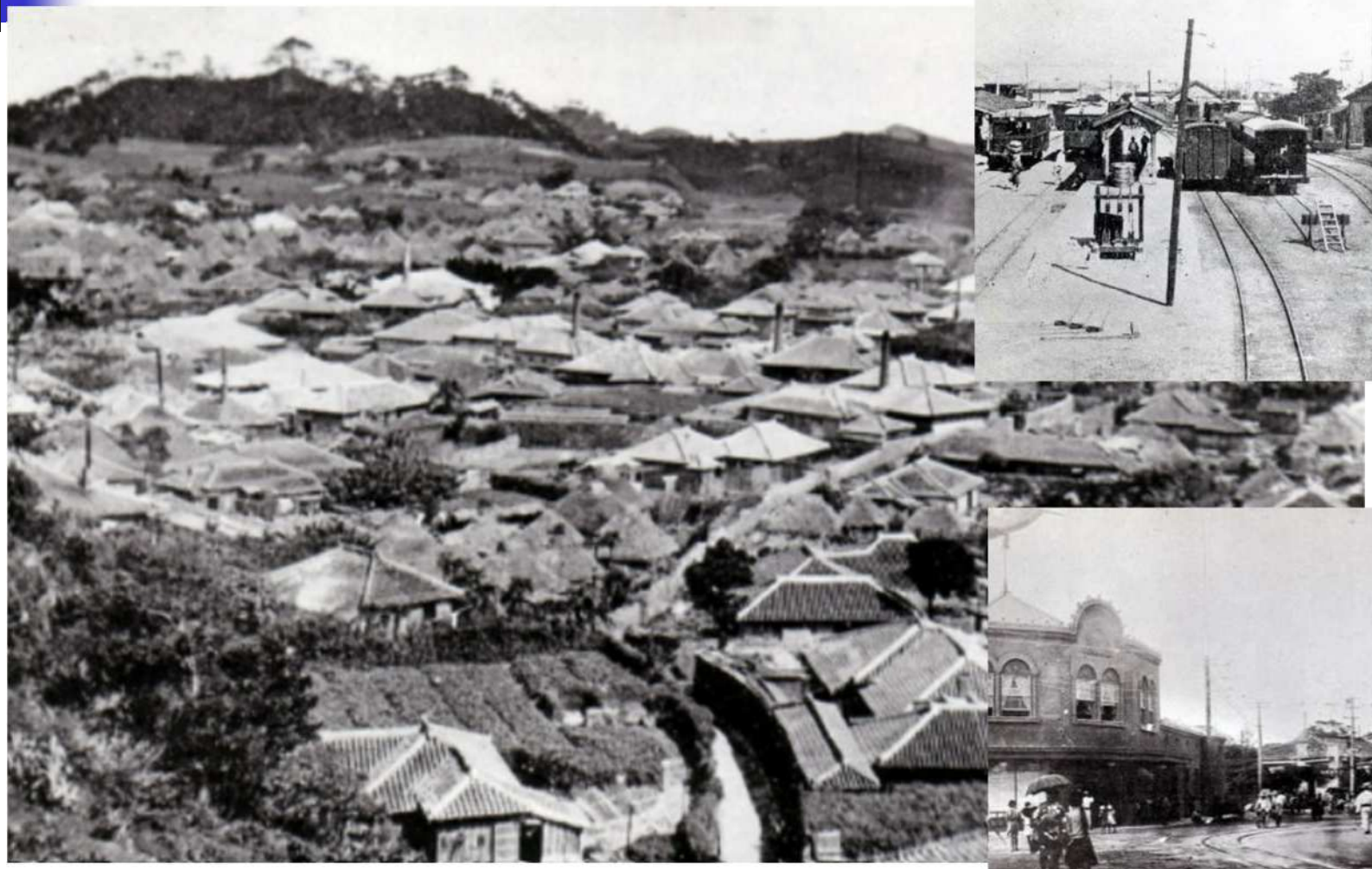
Outline Construction Project Schedule



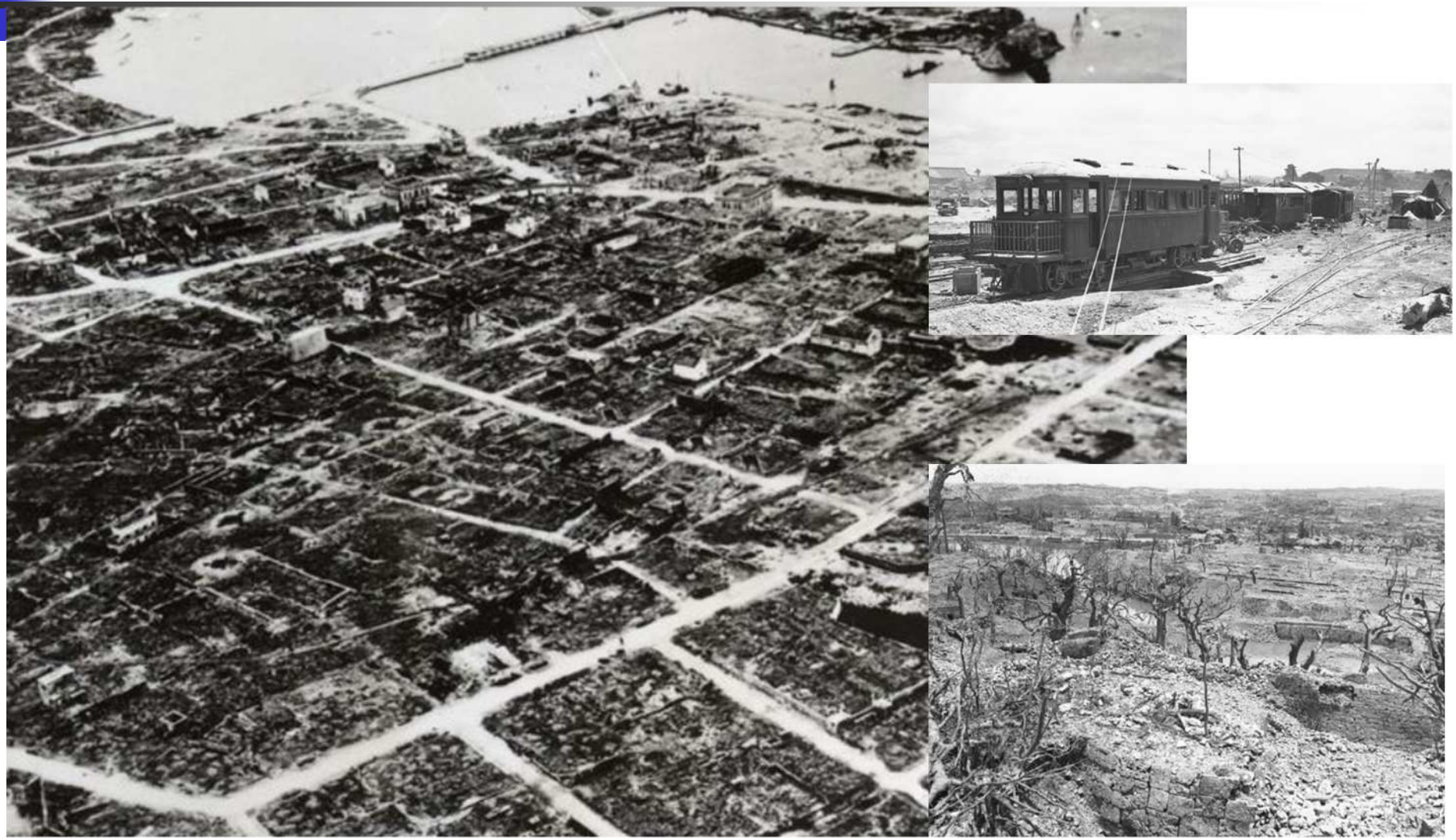
Regarding Unexploded Ordnance Disposal in Okinawa
Why are there unexploded bombs in Okinawa?

- The amount of ammunition used in the prefecture during World War II (Pacific War) is estimated to be about 200,000 tons, of which 10,000 tons, or 5%, was left as unexploded ordnance. Of these, about 3,000 tons were disposed of by residents and 2,500 tons by the U.S. military, and about 2,122 tons were disposed of by the Self-Defense Forces by the 4th fiscal year of Reiwa after the restoration, but even if 500 tons of permanently unknown ammunition are expected, it is estimated that more than 1,878 tons of unexploded ordnance are buried.
  It is said that it will take more than 100 years to dispose of all unexploded ordnance in the prefecture.

Before the war of Okinawa



After the war of Okinawa



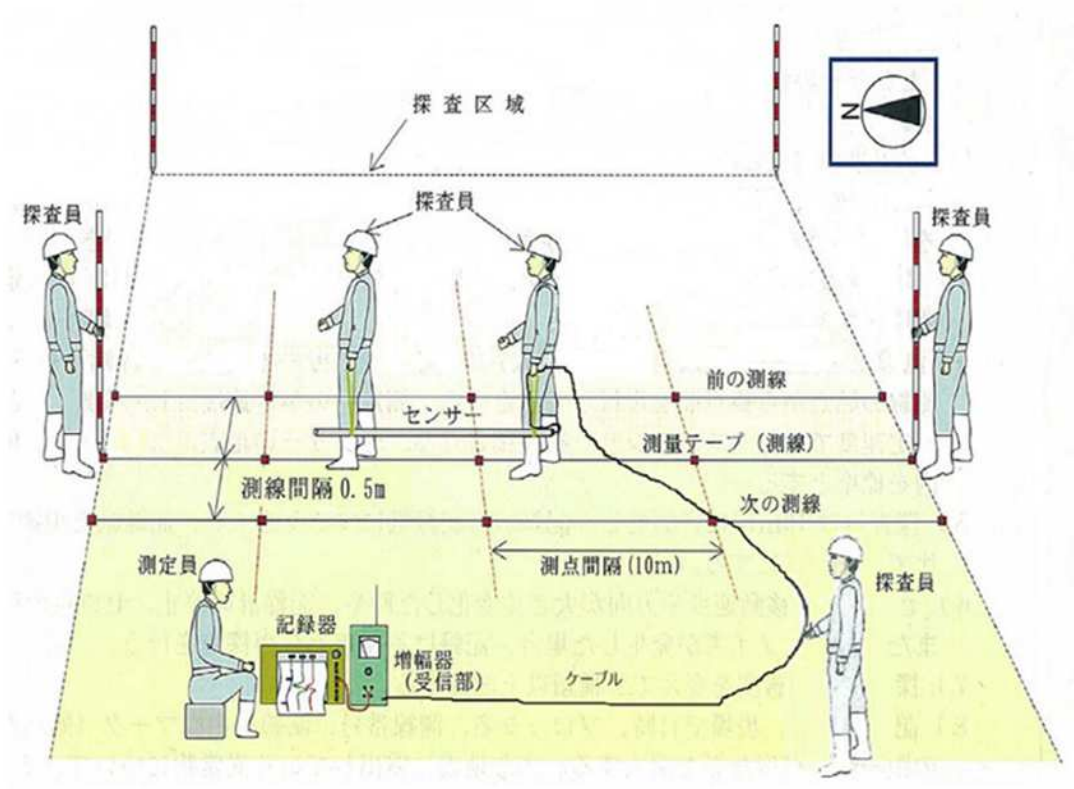
Why is unexploded ordnance detection (magnetic survey) necessary?

- In Okinawa, which was a fierce battlefield during World War II (Pacific War), many unexploded ordnance continue to be discovered, and the number of cases is about 500 per year, and it is still in a dangerous state.
- In 1974, at a sewer pipe construction site near St. Matthew's Kindergarten in Oroku, Naha City, heavy machinery touched a modified landmine buried by the former Japan army and exploded. Four people, including a toddler, were killed, 34 were seriously injured, and 86 houses and 51 vehicles were completely destroyed. In response to this tragedy, in order to protect the lives and property of the people of Okinawa Prefecture, Okinawa Prefecture is conducting an investigation for unexploded ordnance in construction work through the Unexploded Ordnance Disposal Measures Project.

What is magnetic exploration (unexploded ordnance search)?

What is magnetic exploration (unexploded ordnance search)?

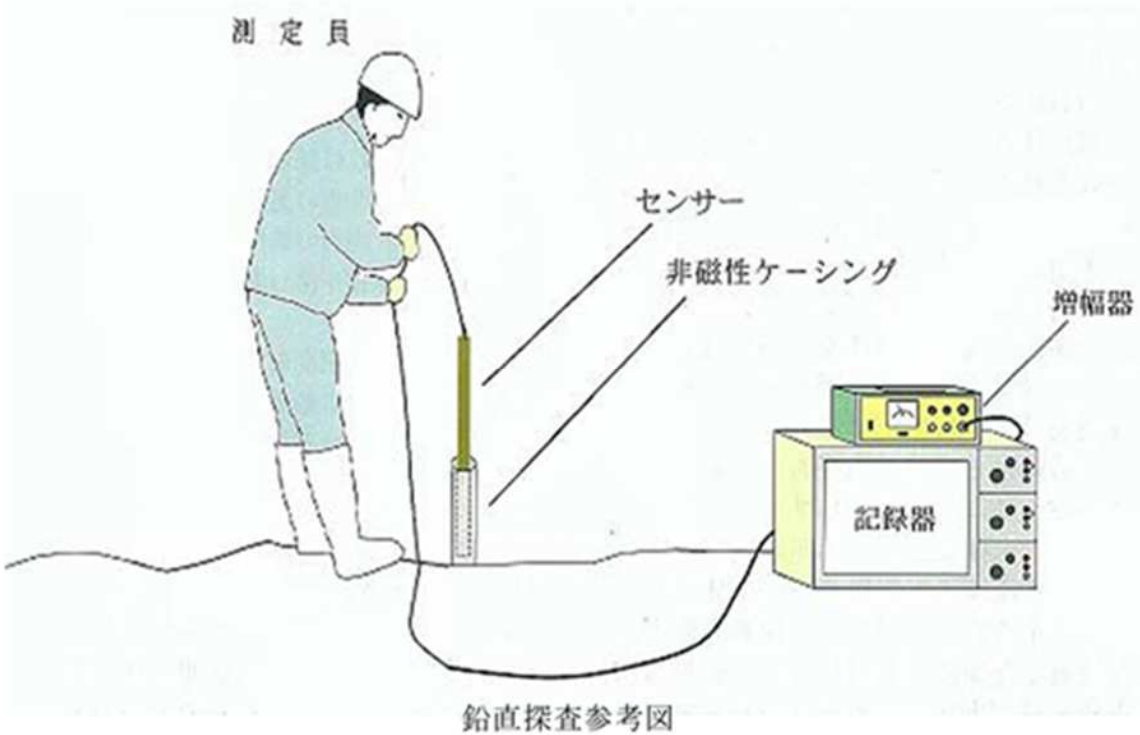
- Magnetic exploration (horizontal exploration)



陸上水平探査参考図
（5インチ砲弾仕様の場合）

What is magnetic exploration (unexploded ordnance search)?

- Magnetic Exploration（Vertical exploration）



鉛直探査参考図

Overview of Magnetic Exploration

Objects containing ferromagnets such as iron, nickel, and cobalt create their own magnetic field in the surrounding space due to the residual magnetism generated by the object's unique magnetic history and the sensitive magnetism generated by sensing the earth's magnetic field, and the magnetic field is locally abnormal. Magnetic exploration of buried objects is a method of estimating the position, depth, and size of buried objects by detecting this magnetic anomaly distribution.

The device used for this exploration is a double-coil type magnetic inclination meter. The double-coil magnetic inclination meter is a method in which two coils are fixed on the same axis and differentially connected, and the difference in magnetism measured by the two coils is detected as an output.

Thank you for your attention

Shuri Castle under restoration (before it burned down)