資　　料

[資料リスト]

1. 調査団員・氏名
2. 調査行程
3. 関係者（面会者）リスト
4. 討議資料（M/D)
5. 参考資料
   5-1 フェリー利用者のヒアリング調査
   5-2 波浪条件解析結果
   5-3 桟橋構造計算結果
6. その他の資料・情報　（現地再委託調査結果）

1. 調査団員・氏名

1-1 現地調査

No.	担当	氏名	所属
1	総括	小柳　桂泉	JIJCA
2	業務主任者／港湾計画	松浦　榮一	Ides
3	港湾施設設計	浅野　敦	JPC
4	自然条件調査	佐瀬　攻	JPC
5	環境社会配慮	山田　正穂	Ides
6	施工・調達計画／積算	西村　進	JPC

1-2 概略設計説明

No.	担当	氏名	所属
1	総括	小柳　桂泉	JIJCA
2	計画管理	工藤　貴裕	JIJCA
3	業務主任者／港湾計画	松浦　榮一	Ides
4	港湾施設設計	浅野　敦	JPC

2. 調査行程

2-1 現地調査

日付	曜日	調査内容					
		総括/JICA	業務主任/港湾計画	港湾施設設計	自然条件	施工・調達計画/積算	環境社会配慮
6月29日	月		成田→シンガポール	成田→シンガポール		成田→シンガポール	
6月30日	火		Arr Dili by MI296 (14:20)	Arr Dili by MI296 (14:20)		Arr Dili by MI296 (14:20)	
7月1日	水		現地調査日程等協議　APORTILとの日程等調整会議	現地調査日程等協議　APORTILとの日程等調整会議		現地調査日程等協議　APORTILとの日程等調整会議	
7月2日	木		IC/R等説明・協議	IC/R等説明協議		IC/R等説明協議	
7月3日	金		APORTIL打合せ	APORTIL打合せ		市場調査。 現地建設業者面談、調査票配布	
7月4日	土		APORTIL打合せ 資料整理	APORTIL打合せ 資料整理		APORTIL打合せ 単価調査。資料整理	
7月5日	日	Arr Dili by GA7300 (12:20) Internal Meeting	団内会議	団内会議		団内会議	
7月6日	月	JICA事務所協議 MD協議(APORTIL) IFC聞き取り調査	JICA事務所協議 MD協議(APORTIL) IFC聞き取り調査	MD協議(APORTIL)	成田→シンガポール	MD協議(APORTIL)	成田→シンガポール
7月7日	火	GIZ Maritime Project聞き取り調査　MD協議(APORTIL)	GIZ Maritime Project聞き取り調査　MD協議(APORTIL)	GIZ Maritime Project聞き取り調査/MD協議(APORTIL)	シンガポール→ディリ 現地調査準備	GIZ Maritime Project聞き取り調査 MD協議(APORTIL)	シンガポール→ディリ　現地調査準備
7月8日	水	MD協議(APORTIL)	MD協議(APORTIL)	MD協議(APORTIL)/現地再委託調査応札書類開封・評価/契契約書署名	JICA表敬訪問 現地再委託業者能力評価	現地再委託調査応札書類開封・評価 /契契約書署名	APORTIL打合せ(IC/P, 質問表等)
7月9日	木	外務協力省　協議 Tibar新港開発状況視察　Dry port 状況視察	外務協力省　協議 Tibar新港開発状況視察　Dry port 状況視察	フェリー旅客ヒアリング項目の検討/Tibar新港開発状況視察/Dry port 状況視察	現地再委託土質調査業者との協議/契約書作成	関税率等調査 Tibar新港開発状況視察 Dry port 状況視察	環境社会配慮聞き取り調査スケジュールの検討/Tibar新港開発状況視察/Dry port 状況視察
7月10日	金	JICA事務所協議 MD協議(APORTIL) IFC聞き取り調査	JICA事務所協議 MD協議(APORTIL) IFC聞き取り調査	現地再委託業者(Package1)調査日程打合せ/契約書作成・処理	現地再委託土質調査業者と契約 海上作業許可申請書作成	現地船会社面談 市場調査	環境社会配慮現地再委託業者内容の精査/APOTIL打合せ
7月11日	土	火山噴火の影響による出発遅延	団内打合せ/資料整理	団内打合せ/資料整理	団内打合せ/現地再委託業者(Package-2)との交渉/契約書作成/JICA報告作成(現地再委託)	団内打合せ/資料整理 第3国調査票送付	団内打合せ/資料整理
7月12日	日	Dep Dili by GA7310 (13:20)	資料整理	資料整理	現地再委託業者(Package-2)との交渉/契約書作成/JICA報告作成(現地再委託)	資料整理	資料整理
7月13日	月		MOTC（Ferry 諸元、計画協議）	MOTC（Ferry 諸元、計画協議）	APORTIL協議(自然条件関連資料の入手について)	税関本局面談。	現地再委託業者・調査日程打合せ
7月14日	火		現地再委託業者作業工程等調整 計画条件の検討	現地再委託業者作業工程等調整 計画条件の検討	現地再委託業者作業工程等調整 計画条件の検討	市場調査。 邦人建設会社調査票配布	資料収集
7月15日	水		MOTC（副大臣とMD内容の確認、署名促進方依頼）	MOTC（副大臣とMD内容の確認、署名促進方依頼）	自然条件資料の収集/再委託業務の進行状況チェック	現地建設業者調査票回収 単価調査	環境省打合せ(環境関連法、資料入手方法等)
7月16日	木		APORTIL打合せ(概略計画案の協議と要望ヒアリング)	APORTIL打合せ(概略計画案の協議と要望ヒアリング)	自然条件資料の収集/再委託業務の進行状況チェック	邦人コンサルタント面談	現地再委託調査状況チェック/協議
7月17日	金		概略配置計画案の検討	概略配置計画案の検討	自然条件資料の収集/再委託業務の進行状況チェック	施工計画検討	環境関連資料の収集
7月18日	土		東側海岸地域への山越えルート視察/団内打合せ	団内打合せ/資料整理	再委託業務の進行状況チェック/資料整理	現地建設業者面談/団内打合せ	団内打合せ/資料整理
7月19日	日		資料整理	資料整理	資料整理	資料整理	資料整理
7月20日	月		APORTIL打合せ(調査進行状況報告及び協議)	APORTIL打合せ(調査進行状況報告及び協議) ナクロマ利用者ヒアリング調査	APORTIL打合せ(調査進行状況報告及び協議)	APORTIL打合せ(調査進行状況報告及び協議) 邦人コンサルタント面談	APORTIL打合せ(調査進行状況報告及び協議)
7月21日	火		現地調査報告書案作成/補足調査	現地調査報告書案作成/補足調査	ビザ延長申請/自然条件資料の収集/再委託業務の進行状況チェック	邦人建設会社面談 単価調査。	APORTIL協議(管理運営体制・運営管理等)
7月22日	水		現地調査報告書案作成/補足調査	現地調査報告書案作成/補足調査	自然条件資料の収集/再委託業務の進行状況チェック	施工計画検討	現地再委託調査状況チェック/協議
7月23日	木		現地調査報告書案作成/補足調査	現地調査報告書案作成/補足調査	自然条件資料の収集/再委託業務の進行状況チェック	概算事業費検討	環境関連資料の収集
7月24日	金		APORTIL打合せ	APORTIL打合せ	APORTIL打合せ/再委託業務の進行状況チェック	APORTIL打合せ	APORTIL打合せ
7月25日	土		団内打合せ/資料整理	団内打合せ/資料整理	団内打合せ/再委託業務の進行状況チェック/資料整理	団内打合せ/資料整理	団内打合せ/資料整理
7月26日	日		資料整理	資料整理	資料整理	資料整理	資料整理
7月27日	月		JICA報告	JICA報告	JICA報告/再委託業務の進行状況チェック	JICA報告	JICA報告/APORTIL打合せ(調査進行状況報告及び協議)
7月28日	火		ディリ→シンガポール	ディリ→シンガポール	自然条件資料の収集/再委託業務の進行状況チェック	ディリ→シンガポール	現地調査報告書案作成、自然・環境調査業者との打合せ・確認作業
7月29日	水		シンガポール→成田	シンガポール→成田	自然条件資料の収集/再委託業務の進行状況チェック	シンガポール→成田	現地調査報告書案作成/補足調査
7月30日	木				自然条件収集資料の整理/再委託業務の進行状況チェック		現地調査報告書案作成/補足調査
7月31日	金				自然条件収集資料の整理/再委託業務の進行状況チェック		JICA打合せ　APORTIL打合せ 環境調査状況確認
8月1日	土				団内打合せ/自然条件収集資料の整理/再委託業務の進行状況チェック		団内打合せ/資料整理
8月2日	日				現地調査報告書案作成/自然条件収集資料の整理/再委託業務の進行状		資料整理
8月3日	月				JICAへの報告/再委託業者の進行状況確認		JICAへの報告 環境調査状況確認
8月4日	火				自然条件資料の収集/再委託業務の進行状況チェック		ディリ→シンガポール
8月5日	水				自然条件資料の収集/再委託業務の進行状況チェック		シンガポール→成田
8月6日	木				現地調査報告書案作成/補足調査		
8月7日	金				現地調査報告書案作成/補足調査		
8月8日	土				自然条件資料の収集/再委託業務の進行状況チェック		
8月9日	日				資料整理		
8月10日	月				資料整理		
8月11日	火				資料整理/再委託業者の進行状況チェック		
8月12日	水				JICAへの報告		
8月13日	木				ディリ→シンガポール		
8月14日	金				シンガポール→成田		

2-2　　概略設計説明

日順	日付	曜日	調査内容			
			総括/JICA	計画管理/JICA	業務主任/港湾計画	港湾施設設計
1	1月25日	月	成田→シンガポール	成田→シンガポール	成田→シンガポール	成田→シンガポール
2	1月26日	火	シンガポール→ディリ　JICA打合せ	シンガポール→ディリ　JICA打合せ	シンガポール→ディリ　JICA打合せ	シンガポール→ディリ　JICA打合せ
3	1月27日	水	MTC副大臣説明 APORTIL説明・協議	MTC副大臣説明 APORTIL説明・協議	MTC副大臣説明 APORTIL説明・協議	MTC副大臣説明 APORTIL説明・協議
4	1月28日	木	APORTIL説明・協議 財務省説明	APORTIL説明・協議 財務省説明	APORTIL説明・協議 財務省説明	APORTIL説明・協議 財務省説明
5	1月29日	金	ミニッツ署名 JICA報告　大使館報告	ミニッツ署名 JICA報告　大使館報告	ミニッツ署名 JICA報告　大使館報告	ミニッツ署名 JICA報告　大使館報告
6	1月30日	土	ディリ→シンガポール	ディリ→シンガポール	ディリ→シンガポール	ディリ→シンガポール
7	1月31日	日	シンガポール→成田	シンガポール→成田	シンガポール→成田	シンガポール→成田

3. 関係者（面会者）リスト

Organization	Name	Position
Ministry of Foreign Affairs and Cooperation	Mr. Nuno Moniz Alves	Director
	Mr. Ines Da Costa Moreira	Desk Officer for Asia and Middle-East
	Mr. Cristiana Gloria	Assistant Administration
Ministry of Finance	Mr. Elson Martinho da Costa	External Assistance Coordination Officer
	Ms. Miranda Santo	ditto
	Mr. Hideaki Maruyama	Advisor
Ministry of Public Works, Transport and Communications	Mr. Inacio Moreira	Vice Minister II
	Mr. Constantino Ferreira Soares	Advisor for Vice Minister
	Mr. Rui Mannel Neto Fragh	Advisor for Vice Minister
	Mr. Teotonio de Assis	Advisor for Vice Minister
Ministry of Commerce, Industry and Environment National Directorate for Environment (NDE) , State Secretariat for Environment	Mr. Antonio Lelo Taci	Director of NDE
	Mr. Francisco Poto	Chief of EIA Department
APORTIL /DNTM	Mr. Constantino Ferreira Soares	President
	Mr. Lino Barreto	Director of DNTM
	Mr. Gabriel Hilario Fernandes	Engineer
	Mr. Jonas F. Alves Do Rego	Operational Security
	Mr. Joes M. Marques	Harbor Master/APORTIL & DNTM
	Mr. Helder da Silva	Technical officer/APORTIL & DNTM
	Ms. Adelina Andrade	Finance /APORTIL
	Mr. Moises de Araiyo	APORTIL
	Mr. Joao de F. Fernandes	DNTM
	Mr. Alberto F Percira	DNTM
	Mr. Hiroyuki Onishi	Advisor/JICA

Custom Department Office	Ms. Rosa de Silva	Head of Commercial Compliance
Meteorological Office	Mr. Eqidio da Costa Butares	Advisor
GIZ	Mr. Rodrigo Garcia-Bernal	Principal Advisor
	Ms. Nadezuda Nikolous	Junior Advisor
IFC	Ms. Milissa Day	Resident Representative, Timor Leste
在東ティモール日本国大使館	山本　栄二	特命全権大使
	川崎　敏秀	参事官
	米光　雅宜	二等書記官
	吉川　幸絵	専門調査員（経済担当）

4. 討議資料(M/D)

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY
FOR THE PROJECT FOR URGENT SHIFT OF FERRY TERMINAL IN DILI PORT
IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

In response to a request from the Government of Democratic Republic of Timor-Leste (hereinafter referred to as "Timor-Leste"), the Government of Japan decided to conduct a Preparatory Survey on "The Project for Urgent Shift of Ferry Terminal in Dili Port" (hereinafter referred to as "the Project"). In accordance with this decision, Japan International Cooperation Agency (hereinafter referred to as "JICA") decided to commence the survey.

JICA sent the Preparatory Survey Team for the Field Survey (hereinafter referred to as "the Team"), which is headed by Mr. Yoshimoto KOYANAGI, Deputy Director, Transportation and ICT Group, Infrastructure and Peacebuilding Department, JICA, and is scheduled to stay in the country from June 30th to August 4th, 2015.

The Team held discussions with the officials concerned of the Timor-Leste side, and conducted a field survey at the Project site.

In the course of discussions and field survey, the both sides confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare a Draft Report of the Preparatory Survey.

Dili, August 25, 2015

小柳 桂泉

Mr. Yoshimoto Koyanagi
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Inácio Freitas Moreira
Vice Ministro das OPC

Ministry of Public Works, Transport and Communications
The Democratic Republic of Timor-Leste

(Witnessed by)

Carlos de Jesus Oliveira
Head of DPMU

Ministry of Finance
The Democratic Republic of Timor-Leste

ATTACHMENT

1. Objective of the Project

The objective of the Project is to achieve a safer port operation by construction of new ferry jetty and necessary facilities, thereby contributing to better environment to port users.

2. Title of the Preparatory Survey

Both sides confirmed the title of the Preparatory Survey as "the Preparatory Survey for the Project for Urgent Shift of Ferry Terminal in Dili Port".

3. Project Site

Both sides confirmed that site of the Project is in Dili Port which is shown in Annex-1.

4. Line Ministry and Executing Agency

Both sides confirmed the line ministry and executing agency as follows:

4-1. The line ministry is Ministry of Public Works, Transport and Communications (MPWTC), which would be the agency to supervise the executing agency.

4-2. The executing agency is Adminstração dos Portos de Timor-Leste (APORTIL). The executing agency shall coordinate with all the relevant agencies to ensure smooth implementation of the Project and ensure that the Undertakings are taken by relevant agencies properly and on time.

4-3. The organization chart is shown in Annex-2.

5. Item requested by the Government of Timor-Leste

5-1. As a result of discussions, with the Team, both sides confirmed that the items requested by the Government of Timor-Leste are as follows:

- Jetty to accommodate two(2) ferries at the same time and landing platform
- Facilities such as water supply, power supply, fire hydrant, lighting system, and safety control system, etc.

5-2. The Team explained to the Timor-Leste side that the ferry to be procured by the Germany in future will be given the higher priority in the process of the examination of the design for new jetty.

5-3. The Timor-Leste side requested to the Team that the countermeasure for sedimentation would be considered for the design of the above mentioned jetty and facilities.

5-4. JICA will assess the appropriateness of the above requested items through the survey and will report findings to the Government of Japan. The final components of the Project

would be decided by the Government of Japan.

6. Japan's Grant Aid Scheme

6-1. The Timor-Leste side understood the Japan's Grant Aid Scheme and its procedures as described in Annex-3, Annex-4 and Annex-5, and necessary measures to be taken by the Government of Timor-Leste.

6-2. The Timor-Leste side agreed to take the necessary measures, as described in Annex-6, for smooth implementation of the Project, as a condition for the Japan's Grant Aid to be implemented. The detailed contents of the Annex-6 will be worked out during the survey and shall be agreed no later than by the Explanation of the Draft Preparatory Survey Report.

The contents of Annex-6 will be used to determine the following:

(1) The scope of the Project.

(2) The timing of the Project implementation.

(3) Timing and possibility of budget allocation

Contents of Annex-6 will be updated as the Preparatory Survey progresses, and will finally be the Attachment to the Grant Agreement.

7. Schedule of the Study

7-1. The Team will proceed with further field survey in Timor-Leste until August 4th, 2015.

7-2. JICA will prepare the draft Preparatory Survey Report and dispatch a mission to Timor-Leste in order to explain its contents around January, 2016.

7-3. If the contents of the draft Preparatory Survey Report is accepted in principle and the Undertakings are fully agreed by the Government of Timor-Leste side, JICA will complete the final report and send it to Timor-Leste around May, 2016.

7-4. The above schedule is tentative and subject to change.

8. Environmental and Social Considerations

8-1. The Timor-Leste side confirmed to give due environmental and social considerations during implementation of the Project, and after completion of the Project, in accordance with the JICA Guidelines for Environment and Social Considerations (April, 2010).

8-2. The Timor-Leste side agreed to conduct the necessary procedures concerning the environmental assessment (including stakeholder meetings, Initial Environmental Examination (IEE) etc.) and submit required environmental report of the Project to the Ministry of Commerce, Industry and Environment. The period required from the request of approval till the obtainment of approval will be further examined, and the Timor-Leste side agreed to obtain the approval from Ministry of Commerce, Industry and Environment and submit it to JICA Timor-Leste Office preferably before the Cabinet

approval of the Project by the Government of Japan which is scheduled around April, 2016.

9. Disclosure of Information

Both sides confirmed that the study results excluding the Project cost will be disclosed to the public after the completion of the Survey. All the study results including the Project cost will be disclosed to the public after all the verification of contracts for the Project are concluded by JICA.

10. Other Relevant Issues

10-1. The Timor-Leste side explained to the Team that Tibar New Port development project is in progress exclusively for cargo handling and that Dili Port will be utilized as a passenger port even after completion of the Tibar Port project.

10-2. The Timor-Leste side explained to the Team their plan for procurement of new ferries of which the ferries from Portugal and Germany will be deployed in a few years. The detailed information on timing of deployment and operation plan by new ferries, etc., will be informed by the Timor-Leste side to the Team by July 27th, 2015.

10-3. The Timor-Leste side agreed that they will construct the passenger terminal building by their own expense by the completion of the project. The both sides will continue technical discussion during the Team's stay till July 27th, 2015, on layout plan of passenger terminal building which is alignment with the construction plan of new jetty and platform. The necessary condition for the outline design work for the new jetty and platform such as passengers' flow, access road route to the platform, shall be agreed during the Team's stay.

10-4. The Timor-Leste side assured that they will secure the necessary budget and personnel for operation and maintenance of the facilities to be provided by the Project.

10-5. The Timor-Leste side agreed to secure the temporary construction yards and the dumping site around the Project site.

10-6. If the dredging work is required to secure the necessary water depth, the Timor-Leste side shall secure the dumping area for the dredged soil which accords to the environmental condition and requirement.

10-7. The Timor-Leste side agreed that the implementing agency (APORTIL) shall bear the cost, which is equivalent to the customs duties, internal taxes and other fiscal levies which may be imposed in Timor-Leste, instead of tax exemption system.

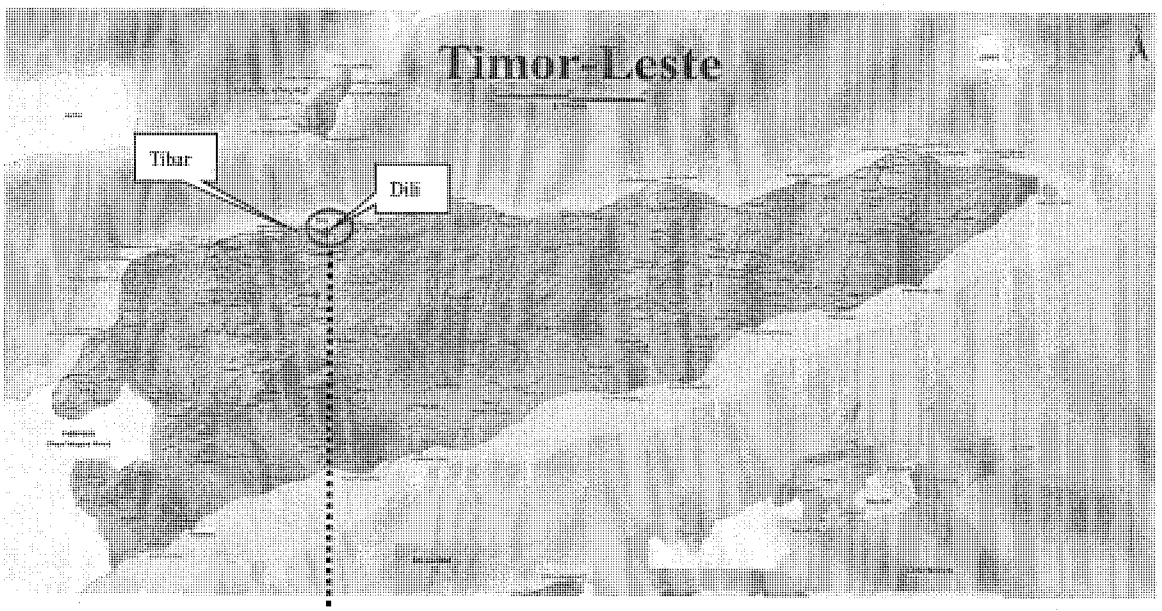
10-8. The both sides agreed to the issuance of the Working Visa for all workers who will be engaged in the project, and agreed that the Timor-Leste side shall take necessary actions to support for the smooth issuance of Working Visa and that the Japanese side shall follow the required procedure in a timely manner.

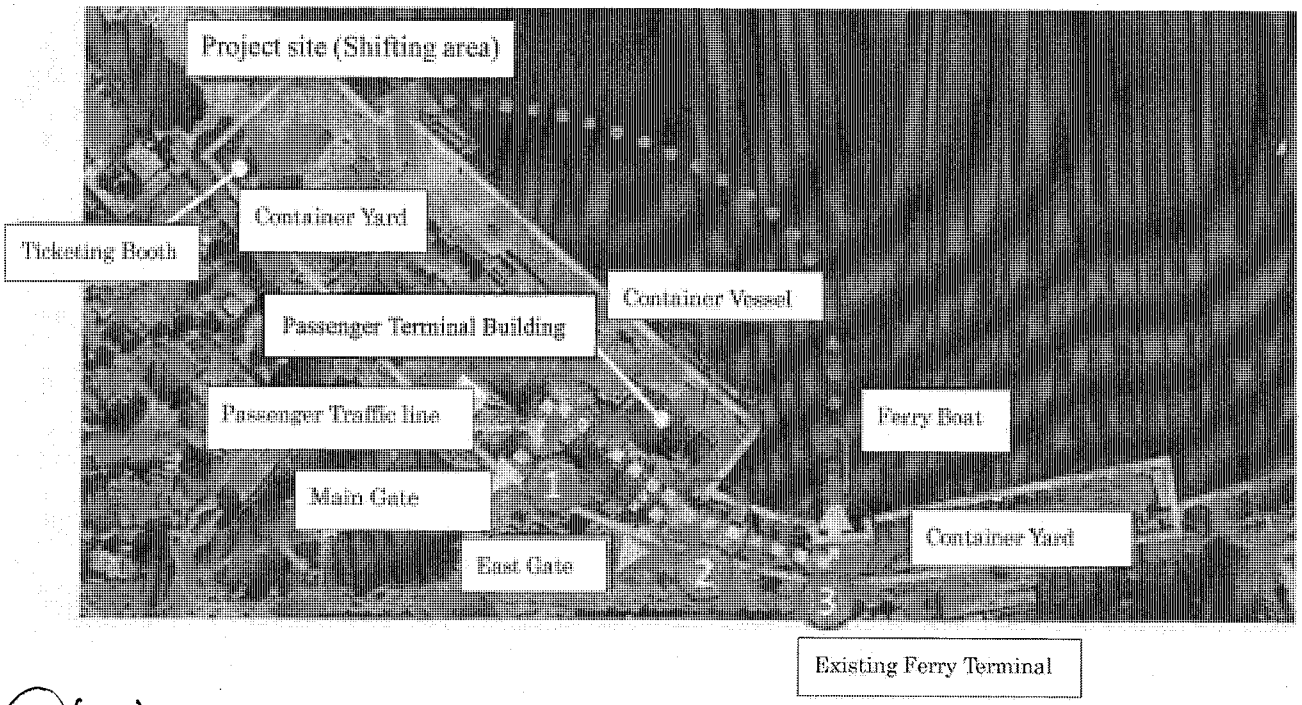
10-9. During implementation and after completion of the Project, the progress and issues will be monitored by using Project Monitoring Report. The format of Project Monitoring Report is attached as Annex-7.

Annex-1	Project Site
Annex-2	Organization Chart
Annex-3	Japan's Grant Aid
Annex-4	Flow Chart of Japan's Grant Aid
Annex-5	Financial Flow of Japan's Grant Aid
Annex-6	Major Undertakings to be taken by Each Government
Annex-7	Project Monitoring Report

Annex-1

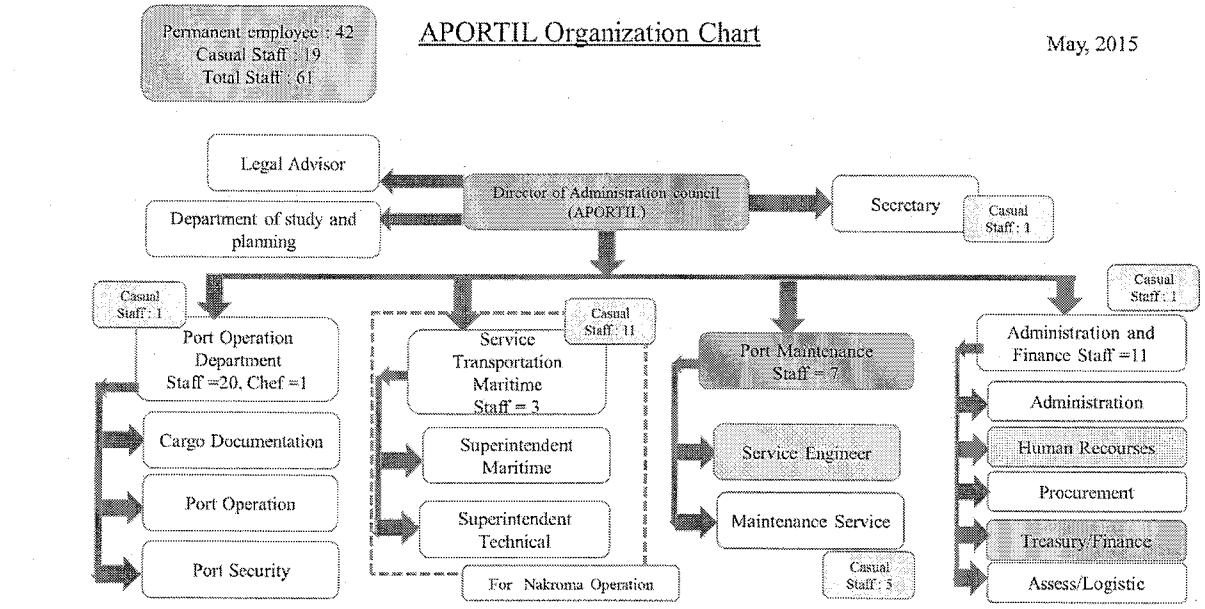
Project Site





Annex-2

Organization Chart



JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

- ·Preparatory Survey
  - The Survey conducted by JICA
- ·Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- ·Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- ·Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- ·Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be

guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants
For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey
JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A
After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants
In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country
Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"
The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country
In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"
The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to

assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"
The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

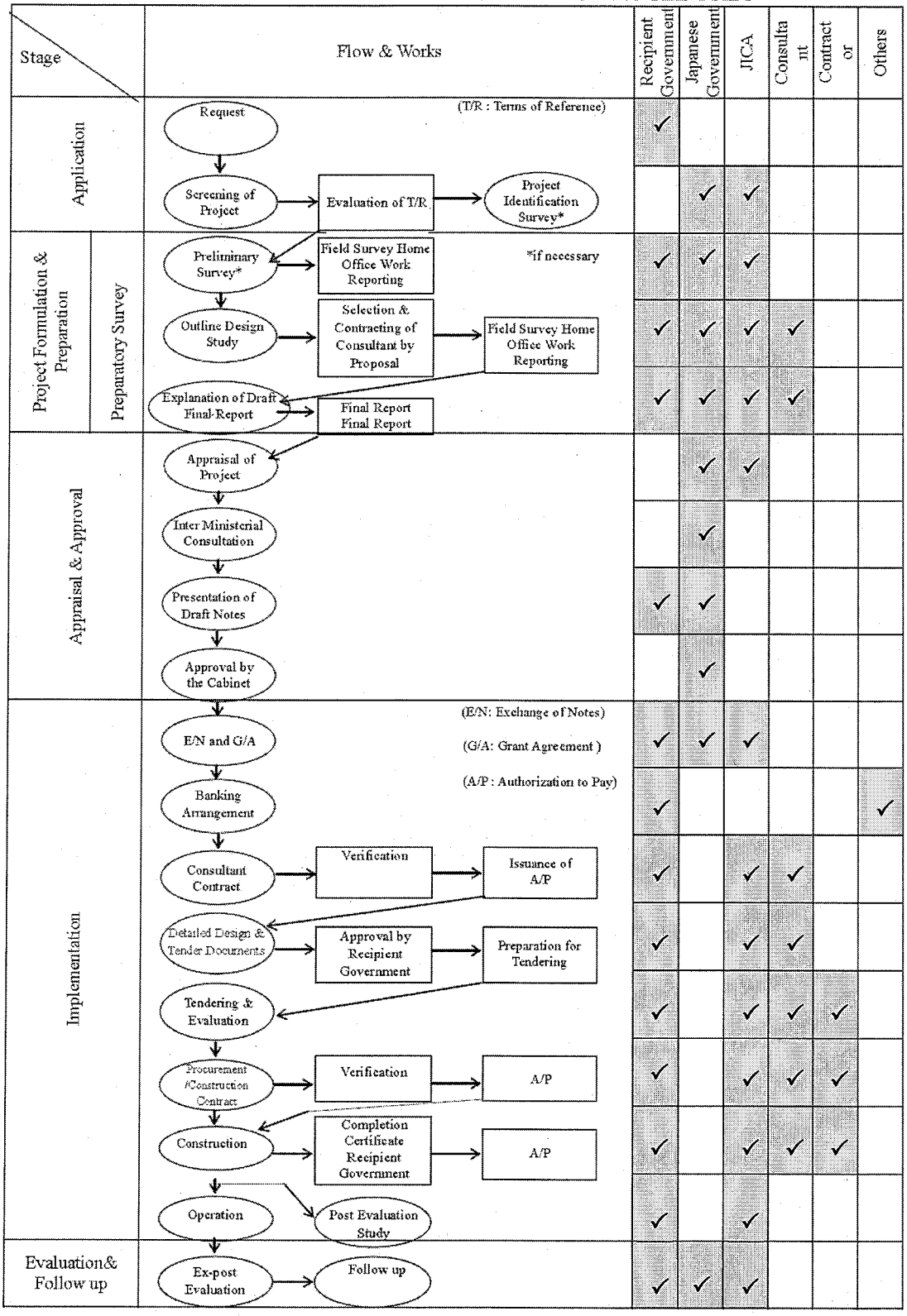
b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

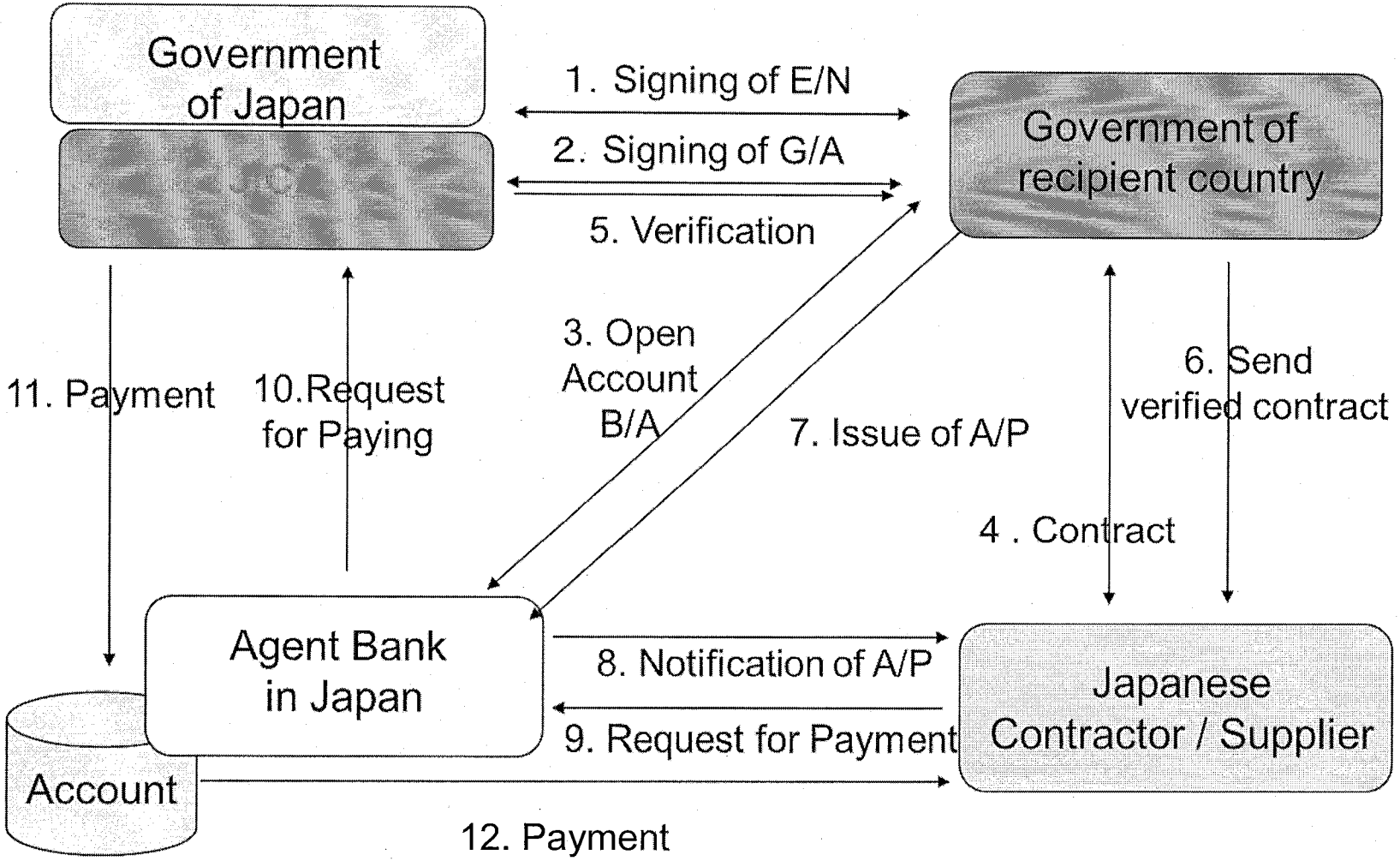
(10) Social and Environmental Considerations
A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

Annex-4

FLOW CHART OF JAPAN'S GRANT AID PROCEDURES



Financial Flow of Grant Aid



Major Undertakings to be taken by Each Government

Major Undertakings to be taken by Recipient Government

1. Before the Tender

NO	Items	Deadline	In charge	Ref.
1	To approve IEE/EIA	before the Project approval by Japanese Cabinet	APORTIL	
2	To open Bank Account (Banking Arrangement (B/A))	within 1 month after G/A	MPWTC	
3	To secure lands 1) temporary construction yard and stock yard near the Project area 2) borrow pit and disposal site near the Project area	before notice of the tender document	APORTIL	
4	To obtain the planning, zoning, building permit	before notice of the tender document	APORTIL	
5	To clear, level and reclaim the following sites when needed	before notice of the tender document	APORTIL	

2. During the Project Implementation

NO	Items	Deadline	In charge	Ref.
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A			
	1) Advising commission of A/P	within 1 month after the singing of the contract	MOF	
	2) Payment commission for A/P	every payment	APORTIL	
2	To issue the Working Visa for workers	before commencement of the Project	Ministry of Internal Affairs	
3	To construct the passenger terminal building	during the Project	APORTIL	
4	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country	during the Project	APORTIL	
5	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work	during the Project	APORTIL	
6	To bear the cost which is equivalent to the customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the Products and/or the Services, instead of tax exemption system. Such customs duties, internal taxes and other fiscal levies mentioned above include VAT, commercial tax, income tax and corporate tax of Japanese nationals, resident tax, fuel tax, but not limited, which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract	during the Project	APORTIL	
7	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the Project implementation	during the Project	APORTIL	
8	To submit environmental monitoring report to JICA Timor-Leste Office	during the Project	APORTIL	

3. After the Project

NO	Items	Deadline	In charge	Ref.
1	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine/Periodic inspection	After completion of the construction	APORTIL	

Major Undertakings to be covered by the Grant Aid

No	Items	Deadline	Cost Estimated (Million Japanese Yen)*	
1	To construct ferry terminal jetty and necessary facilities (or To procure equipment)			
	- Improvement of ferry terminal jetty			
	- Improvement of necessary facilities			
	1) To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country		XX.XX	
	a) Marine(Air) transportation of the products from Japan to the recipient country			
	b) Internal transportation from the port of disembarkation to the project site			
	2) To construct access roads			
	a) Within the site			
2	To implement detailed design, tender support and construction supervision (Consultant)		YY.YY	
3	Contingencies		ww.ww	
	Total		ZZ.ZZ	

(Sample)

Project Monitoring Report

on

Project Name

Grant Agreement No. XXXXXXX

Organization Information

Authority (Signer of the G/A)	Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Executing Agency	Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Line Ministry	Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____

Outline of Grant Agreement:

Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____
Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:

1: Project Description

1-1 Project Objective

1-2 Necessity and Priority of the Project

- Consistency with development policy, sector plan, national/regional development plans and demand of target group and the recipient country.

1-3 Effectiveness and the indicators

- Effectiveness by the project

2: Project Implementation

2-1 Project Scope

Table 2-1-1a: Comparison of Original and Actual Location

Location	**Original:** *(M/D)* **Attachment(s):Map**	**Actual:** *(P/Rand PCR)* **Attachment(s):Map**

Table 2-1-1b: Comparison of Original and Actual Scope

Items	Original	Actual
(M/D)	*(M/D)*	*(P/R and PCR)*

2-1-2 Reason(s) for the modification if there have been any.

(P/R and PCR)

2-2 Implementation Schedule

2-2-1 Implementation Schedule

Table 2-2-1: Comparison of Original and Actual Schedule

Items	Original		Actual
	DOD	G/A	
[M/D] Project Completion Date*	*(M/D)*		*(P/R,PCR)* As of (Date of Revision) Please state not only the most updated schedule but also other past revisions chronologically.

*Project Completion was defined as _____ at the time of G/A.

2-2-2 Reasons for any changes of the schedule, and their effects on the project.

(P/R and PCR)

2-3 Undertakings by each Government

2-3-1 Major Undertakings

See Attachment 2.

2-3-2 Activities

See Attachment 3.

2-4 Project Cost

2-4-1 Project Cost

Table 2-3-1 Comparison of Original and Actual Cost by the Government of Japan
(Confidential until the Tender)

Items			Cost (Million Yen)	
	Original	Actual	Original	Actual
Construction Facilities (or Equipment)				
Consulting Services	- Detailed design -Procurement Management -Construction Supervision			

Total		

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

Table 2-3-2 Comparison of Original and Actual Cost by the Government of XX

Items			Cost (Million USD)	
	Original	Actual	Original	Actual
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = (local currency)

2-4-2 Reason(s) for the wide gap between the original and actual, if there have been any, the remedies you have taken, and their results.

(P/R, PCR)

2-5 Organizations for Implementation

2-5-1 Executing Agency:

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original: *(M/D)*
Actual, if changed: *(P/R and PCR)*

2-6 Environmental and Social Impacts

Report based on the agreed environmental checklist and monitoring form (See Attachment 4)

3: Operation and Maintenance (O&M)

3-1 O&M and Management

- Organization chart of O&M
- Operational and maintenance system (structure and the number ,qualification and skill of staff or other conditions necessary to maintain the outputs and benefits of the project soundly, such as manuals, facilities and equipment for maintenance, and spare part stocks etc)

Original: *(M/D)*
Actual: *(PCR)*

3-2 O&M Cost and Budget

- The actual annual O&M cost for the duration of the project up to today, as well as the annual O&M budget.

Original: *(M/D)*

4: Precautions (Risk Management)

- Risks and issues, if any, which may affect the project implementation, outcome, sustainability and planned countermeasures to be adapted are below.

Original Issues and Countermeasure(s): *(M/D)*	
Potential Project Risks	Assessment
1.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:

	Contingency Plan (if applicable):
2.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
3.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
Actual issues and Countermeasure(s)	
(P/R and PCR)	

5: Evaluation

5-1 Overall evaluation

Please describe your evaluation on the overall outcome of the project.

(PCR)

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

(PCR)

Attachment

1. Project Location Map
2. Undertakings to be taken by each Government
3. Monthly Report
4. Monitoring report on environmental and social considerations

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR THE PROJECT FOR
URGENT SHIFT OF FERRY TERMINAL IN DILI PORT
(EXPLANATION ON DRAFT PREPARATORY SURVEY REPORT)

On the basis of the discussions and field survey in the Democratic Republic of Timor-Leste (hereinafter referred to as "Timor-Leste") in July, 2015, and the subsequent technical examination of the results in Japan, the Japan International Cooperation Agency (hereinafter referred to as "JICA") prepared a draft Preparatory Survey Report (hereinafter referred to as "the Draft Report") on the Project for urgent shift of ferry terminal in Dili Port (hereinafter referred to as "the Project").

In order to explain the Draft Report and to consult with the concerned officials of the Government of Timor-Leste on its contents, JICA sent to Timor-Leste the Preparatory Survey Team for the explanation of the Draft Report (hereinafter referred to as "the Team"), headed by Mr. Yoshimoto KOYANAGI, Deputy Director, Transportation and ICT Group, Infrastructure and Peacebuilding Department, JICA, from January 26 to 30, 2016.

As a result of the discussions, both sides confirmed the main items described in the attached sheets.

Dili, January 29th, 2016

Mr. Yoshimoto Koyanagi
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Mr. Constantino Ferreira Soares
Presidente
Adminstração dos Portos de Timor-Leste
The Democratic Republic of Timor-Leste

(Witnessed by)

Mr. Cancio de Jesus Oliveira
Director
Development Partnership Management Unit
Ministry of Finance
The Democratic Republic of Timor-Leste

ATTACHEMENT

1. Objective of the project

   The objective of the Project is to achieve a safer port operation by construction of new ferry jetty and necessary facilities, thereby contributing to better environment to port users.

2. Project Site

   Both sides confirmed that site of the Project is in Dili Port which is shown in Annex-1.

3. Line Agency and Executing Agency

   Both sides confirmed the line agency and executing agency as follows:

3-1. The line ministry is Ministry of Public Works, Transport and Communications (MPWTC), which would be the agency to supervise the executing agency.

3-2. The executing agency is Adminstração dos Portos de Timor-Leste (APORTIL). The executing agency shall coordinate with all the relevant agencies to ensure smooth implementation of the Project and ensure that the Undertakings are taken by relevant agencies properly and on time. The Timor-Leste side explained to the Team that APORTIL has been reorgamized as a financially independent entity responsible for operation and maintenance of port facilities from January 2016, and is an authorized agency for implementation of the Project including budgetary authority.

3-3. The organization chart is shown in Annex-2.

4. Contents of the Draft Report

   After the explanation of the contents of the Draft Report by the Team, the Timor-Leste side agreed in principle to its contents.

5. Cost Estimation

   Both sides confirmed that the Project cost estimation described in Annex-3 is provisional and would be examined further by the Government of Japan for its final approval.

6. Confidentiality of the Cost Estimation and Specifications

Both sides confirmed that the Project cost estimation and technical specifications in the Draft Report should never be duplicated or disclosed to any third parties until all the contracts of the Project are concluded.

7. Japan's Grant Aid Scheme

The Timor-Leste side understood the Japan's Grant Aid Scheme and its procedures as described in Annex-4, Annex-5 and Annex-6, and necessary measures to be taken by the Government of Timor-Leste.

8. Project Implementation Schedule

The Team explained to the Timor-Leste side that the expected implementation schedule is as attached in Annex-7.

9. Expected outcomes and Indicators

Both sides agreed that key indicators for expected outcomes are as follows. The Timor-Leste side has responsibility to monitor the progress of the indicators and achieve the target in year 2021.

[Quantitative Effect]

Indices	Basis (at 2014)	Target (at 2021, three years after completion of the Project)
Berthing hours of Ferry (hours per day)	3 hours per day	24 hours
Annual number of Passenger	Atauro : 21,634 passengers Oecussi : 44,036 passengers	Atauro : 28,392 passengers Oecussi : 70,985 passengers

[Qualitative Effect]

(1) Direct effects

- Improvement of safety for the passenger's embarkation and disembarkation
- Safe berthing of ferry regardless the tide level
- User-friendly terminal with the passenger terminal close by
- The jetty reduces the deflection of the ferry during the approach to the terminal. As a result, flexibility in bunkering work will be highly increased.
- Better transportation services for people because of more flexible navigation schedule and larger transportation volume due to the double berthing jetty
- Contribution to the development of new international Ferry Routes because of the character of the ferry (Ro/Ro type) to be introduced from Portugal.

(2) In-direct effects

- Contribution to the economic development of the enclave, islands and the northern coast with increased commodity between the rural areas and the capital city
- Conducing the rural economic development as potential transportation measures for tourists which are expected to increase in the future
- Clear demarcation of the role of Dili Port as nodal port for the International tourists and for domestic ferry after transfer of cargo function to the new port in Tibar.

10. Undertakings Taken by Both Sides

Both sides confirmed undertakings described in Annex-8. The Timor-Leste side assured to take the necessary measures and coordination including allocation of the necessary budget which are preconditions of implementation of the Project. It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs will be calculated at the Detailed Design stage. Contents of Annex-8 will be updated as the Detailed Design progresses, and will finally be the Attachment to the Grant Agreement.

11. Monitoring during the Implementation

The Project will be monitored every six months during the project period by the executing agency using the Project Monitoring Report (PMR) described in Annex-9.

12. Ex-Post Evaluation

JICA will conduct ex-post evaluation three (3) years after the project completion with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, Sustainability) of the Project. Result of the evaluation will be publicized. The Timor-Leste side is required to provide necessary support for them.

13. Schedule of the Study

JICA will complete the Final Report of the Preparatory Survey in accordance with the confirmed items and send it to the Timor-Leste side around May, 2016.

14. Environmental and Social Considerations

14-1 General Issues

14-1-1 Environmental Guidelines and Environmental Category

The Team explained that "JICA Guidelines for Environmental and Social Considerations (April 2010)" (hereinafter referred to as "the Guidelines") is applicable for the Project. The Project is categorized as B because the Project is not located in a sensitive area, nor has it sensitive characteristics, nor falls it into sensitive sectors under the Guidelines, and its potential adverse impacts on the environment are not likely to be significant.

14-1-2 Environmental Checklist

The environmental and social considerations including major impacts and mitigation measures for the Project are summarized in the Environmental Checklist attached as Annex-10. Both sides confirmed that in case of major modification of the content of the Environmental Checklist, The Timor-Leste side shall submit the modified version to JICA in a timely manner.

14-2 Environmental Issues

14-2-1 Initial Environmental Examination (IEE)

The Timor-Leste side agreed to conduct the necessary procedures concerning the environmental assessment (including stakeholder meetings, Initial Environmental Examination (IEE) etc.) and submit required environmental report of the Project to the Ministry of Commerce, Industry and Environment, and the Timor-Leste side agreed to obtain the approval of the necessary environment document from Ministry of Commerce, Industry and Environment and submit it to JICA Timor-Leste Office preferably before the Cabinet approval of the Project by the Government of Japan which is scheduled around April, 2016.

14-2-2 Environmental Monitoring Plan

The Timor-Leste side agreed that monitoring for environmental and social considerations will be conducted by the responsibility of APORTIL in accordance with the Environmental Monitoring Plan described in the Draft Report. The results of monitoring will be provided to JICA Timor-Leste Office by filling in the Environmental Monitoring Form attached as Annex-11, during construction phase and after completion of the Project.

14-3 Information Disclosure of Monitoring Results

Both sides confirmed that the Timor-Leste side will disclose results of environmental and social monitoring to local stakeholders in their office and/or through their website.

The Timor-Leste side agreed that JICA will disclose results of environmental and

social monitoring submitted by the Timor-Leste side as the monitoring forms attach as Annex-11 on its website.

15. Other Relevant Issues

15-1. Operation and Maintenance of the Facilities

The team explained the importance of operation and maintenance of the facilities constructed by the Project considering that proper asset management impacts greatly on life-span of the facilities and its maintenance cost. The Timor-Leste side shall secure enough staff and budgets necessary for appropriate operation and maintenance of the facilities. The annual operation and maintenance costs are estimated and shown in Annex 12.

15-2. Safety Measures

To avoid accidents on site during the implementation of the Project, the Timor-Leste side agreed to cause the consultant and the contractor to enforce safety measures such as setting safety assurance to the site, providing information for security control to public, and deploying adequate security personnel, based on "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" which has been published on JICA's URL below.

http://www.jica.go.jp/activities/schemes/oda_safety/ku57pq00001nz4eu-att/guidance_en.pdf

15-3. Misconduct

If JICA receives information related to suspected corrupt or fraudulent practices in the implementation of the Project, APORTIL and relevant organizations will provide JICA with such information as JICA may reasonably request, including information related to any concerned official of the government and/or public organizations of Timor-Leste.

APORTIL and relevant organizations will not, unfairly or unfavorably treat the person and/or company which provided the information related to suspected corrupt or fraudulent practices in the implementation of the Project.

15-4. Disclosure of Information

Both sides confirmed that the study results excluding the Project cost will be disclosed to the public after completion of the Preparatory Survey. All the study results including the project cost will be disclosed to the public after all the contracts for the Project are concluded.

15-5. Operation of Dili Port

The Timor-Leste side explained to the Team that they don't have any plan of

concession contract on the operation of Dili Port to any private company from other country and that Dili port will be operated by the Government of Timor-Lest (APORTIL).

15-6. Temporary Construction Yard, Borrow Pit and Disposal Site

The Timor-Leste side agreed to secure the temporary construction yard, borrow pit and disposal site near the Project site before tender notice of the Project and also agreed to demolish the blockage in the construction yard before commencement of the construction work with the coordination/adjustment with contractor(s).

15-7. Passenger Terminal

The Timor-Leste side explained to the Team about construction plan of passenger terminal and also explained that the passenger terminal will be completed by the end of the Project.

15-8. Progress of New Ferries

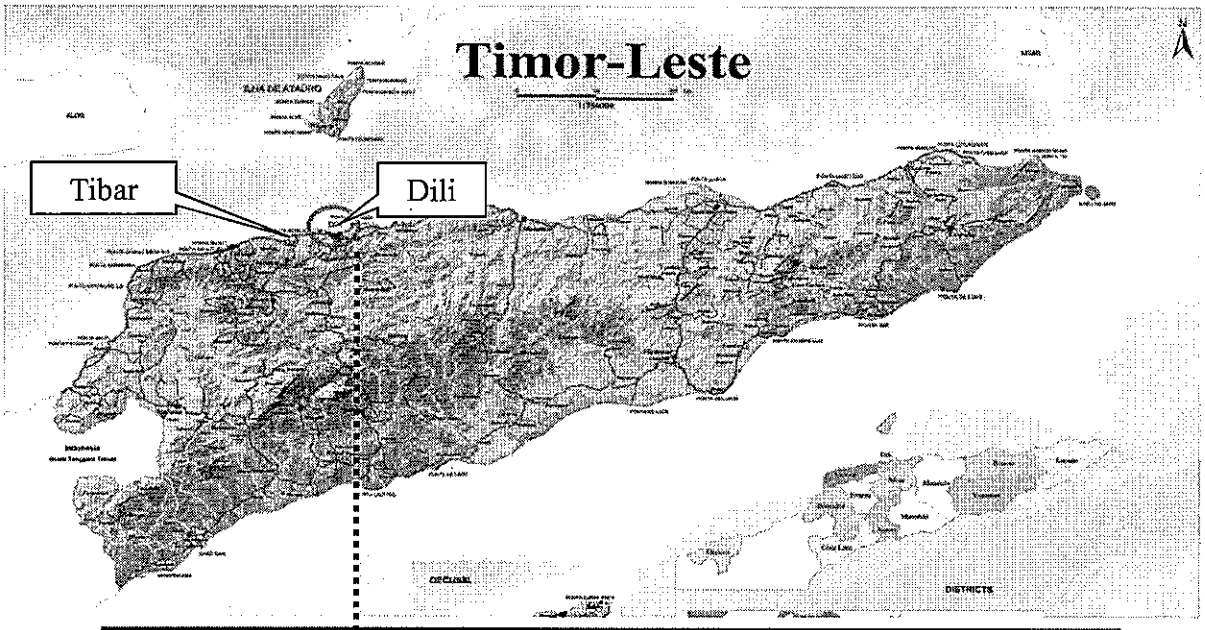
The Timor-Leste side explained to the Team about the progress of procurement of new ferries of which the ferry from Portugal and Germany will be deployed around the end of 2016 and mid-term of 2017 respectively.

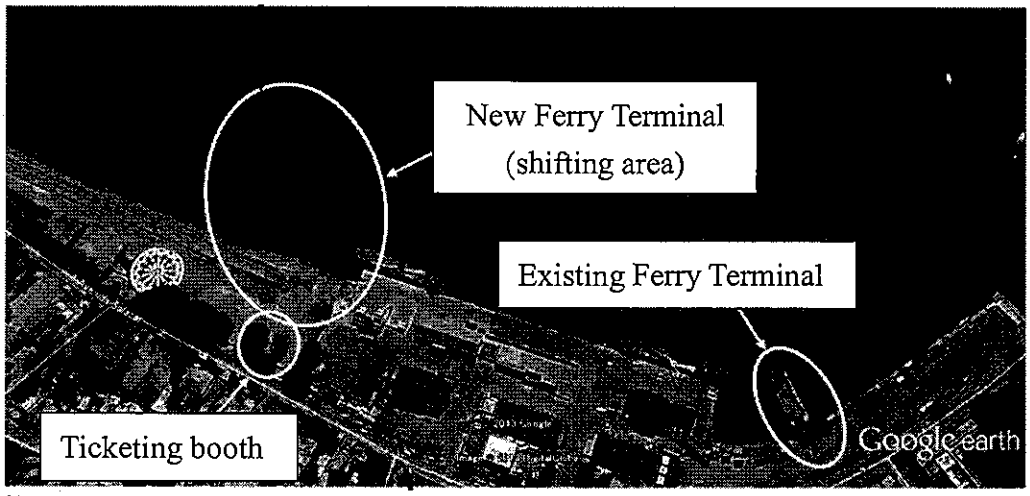
15-9. Working Visa

Both sides agreed the necessary procedure for the issuance of Working Visa for all workers who will be engaged in the project, and agreed that both sides shall follow the required procedure and take necessary actions in a timely manner respectively.

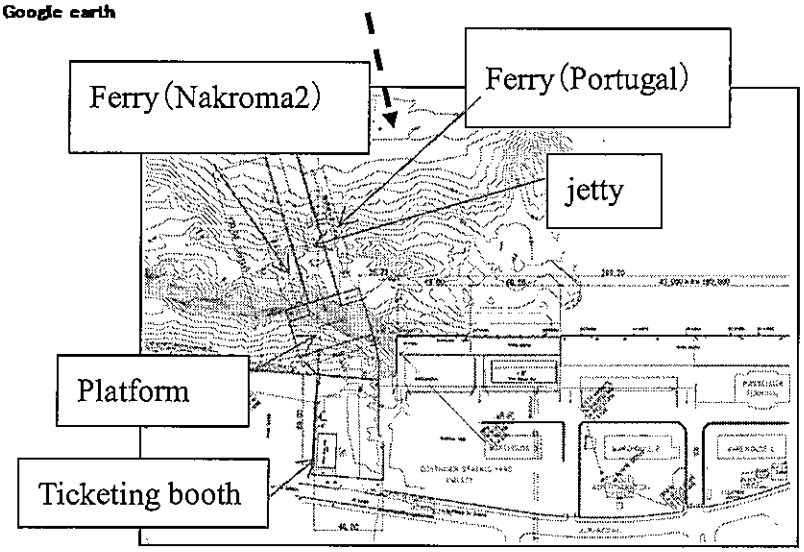
Annex-1 Project site
Annex-2 Organization Chart
Annex-3 Project Cost Estimation
Annex-4 Japan's Grant Aid
Annex-5 Flow Chart of Japan's Grant Aid
Annex-6 Financial Flow of Japan's Grant Aid
Annex-7 Project Implementation Schedule
Annex-8 Major Undertakings to be taken by Each Government
Annex-9 Project Monitoring Report (PMR)
Annex-10 Environmental Checklist
Annex-11 Environmental Monitoring Form
Annex-12 Operation and Maintenance Cost

Project Sites





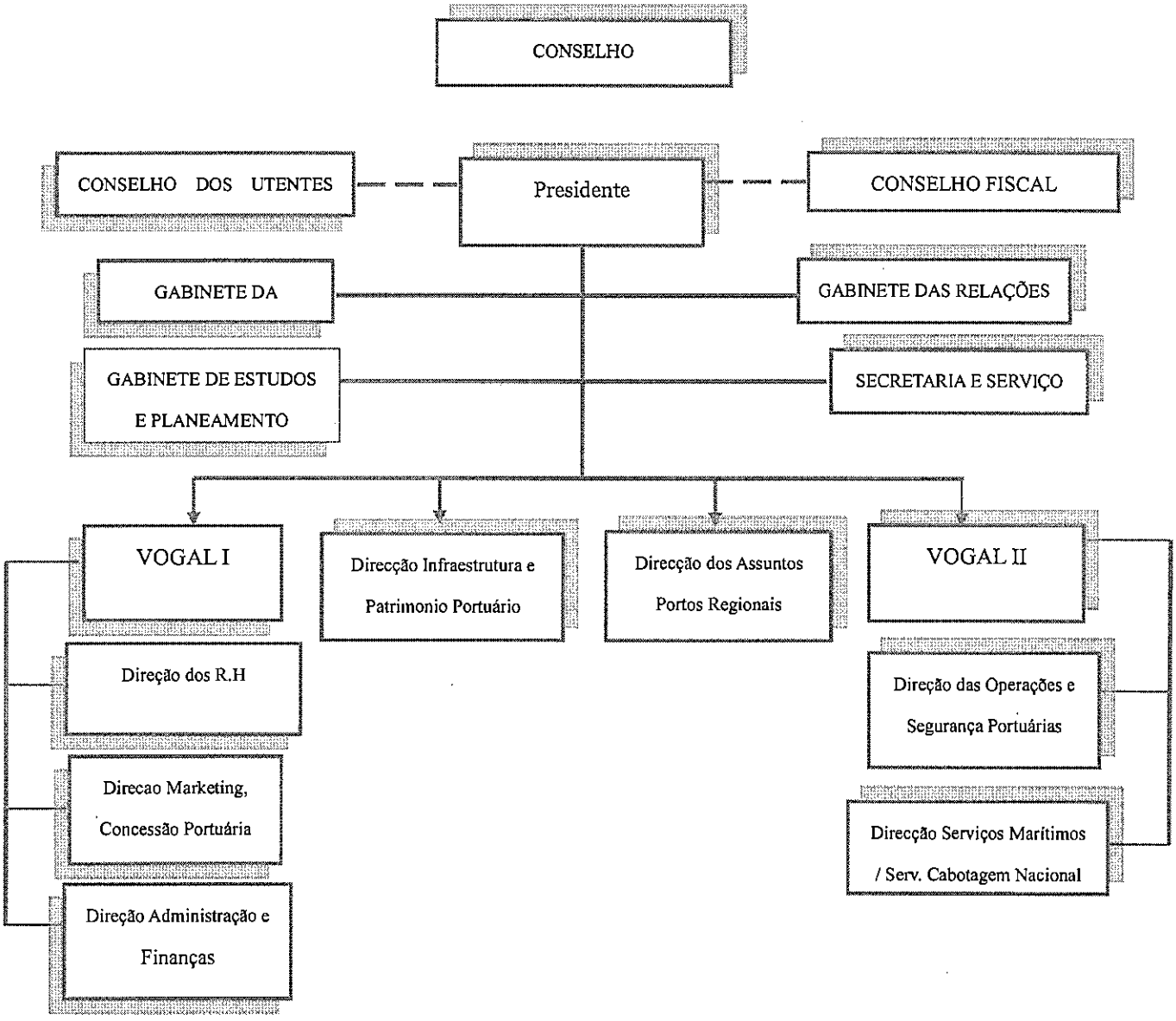
出典：Google earth



Layout plan

Annex-2

Organization Chart



Project Cost Estimation

(1) Cost Borne by the Government of Japan

Description	Estimated Cost (million Yen)
Facilities	1,999
Detailed design and Construction supervision	132
TOTAL	**2,131**

(2) Cost Borne by the Government of Timor-Leste

Description	Estimated Cost (USD)	Converted to Japanese Yen (million JPY)
Land purchased fee	State property	-
Demolition of the blockage in the construction yard	19,500	2.42
Construction of New Ferry Terminal Building	1,036,700	128.24
Import tax for the everlasting construction materials (2.5%)	72,500	8.97
Necessary cost of Banking Arrangement	17,200	2.13
TOTAL	**1,145,900**	**141.76**

Notes:

(1) The cost estimates in the above table are provisional and will be further examined by the Government of Japan for the approval of the Grant.

(2) The total cost of the project JPY 141.76 million is equivalent to USD 1.15 million at the current exchange rate; USD 1.0=JPY 123.70

JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- ·Preparatory Survey
  - The Survey conducted by JICA
- ·Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- ·Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- ·Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- ·Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be

guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants
For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey
JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A
After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants
In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country
Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"
The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country
In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"
The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to

assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"
The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

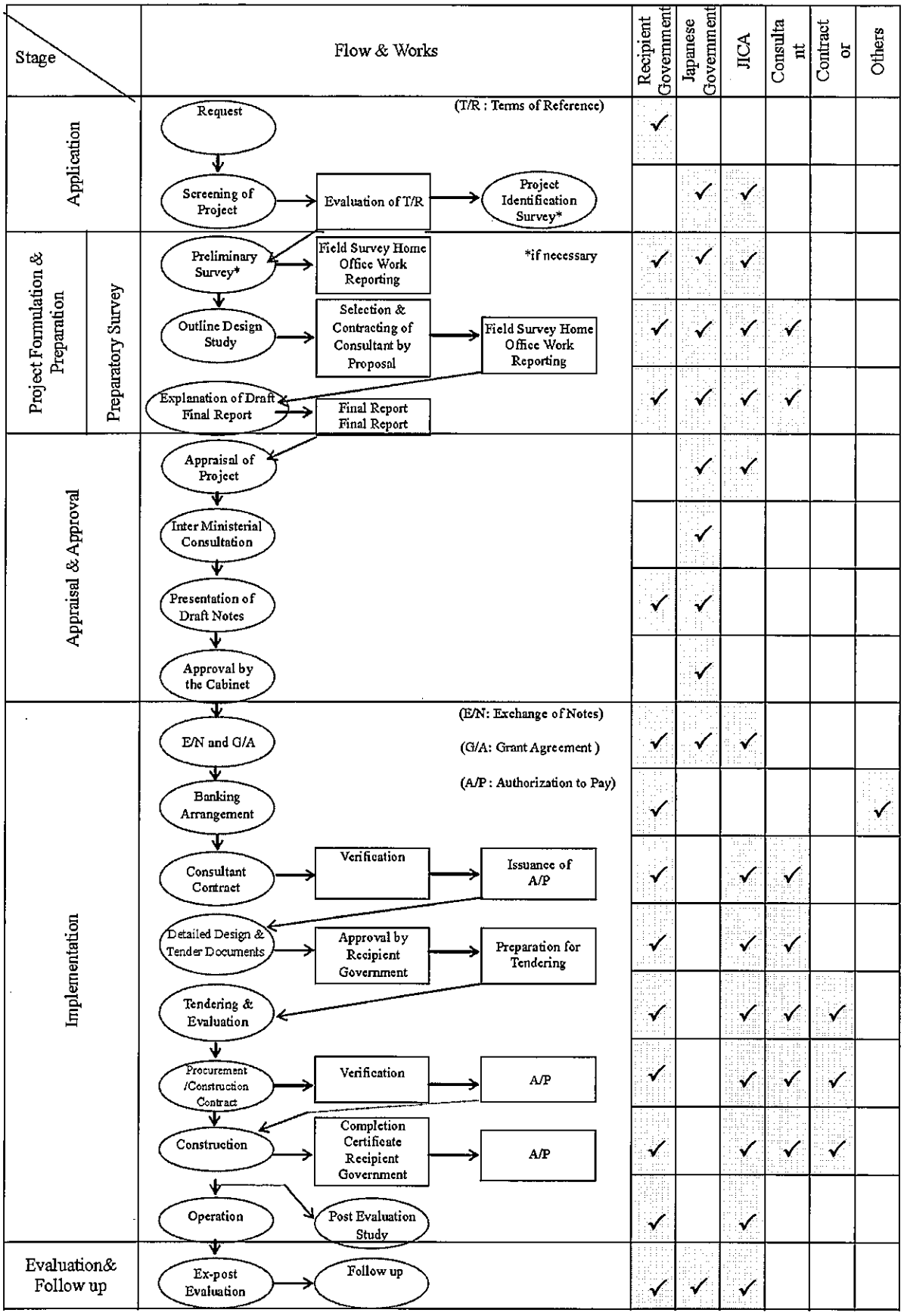
a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

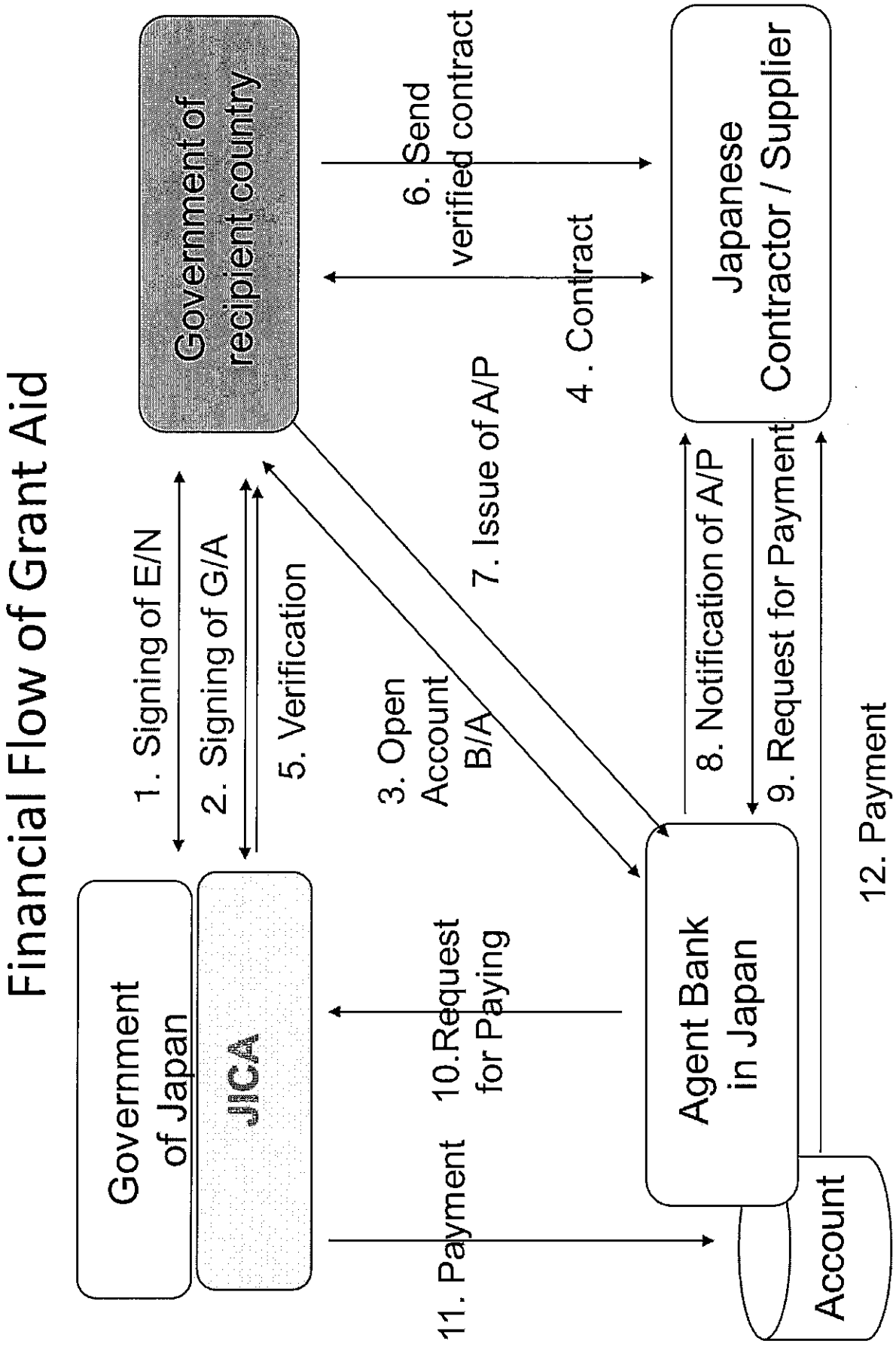
b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

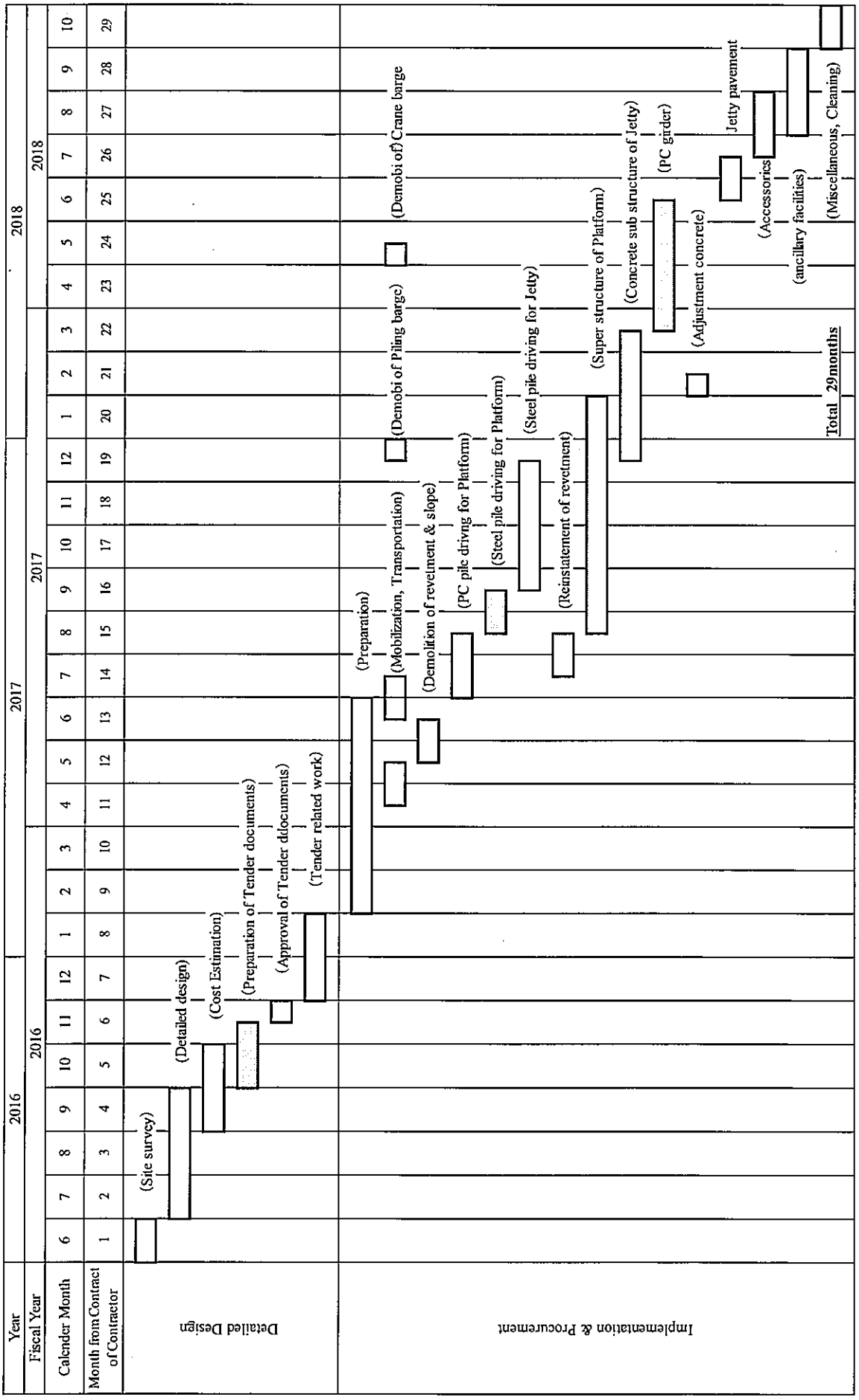
(10) Social and Environmental Considerations
A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

FLOW CHART OF JAPAN'S GRANT AID PROCEDURES




Financial Flow of Grant Aid
Government of recipient country
Japanese Contractor / Supplier
Government of Japan
JICA
Agent Bank in Japan
Account
1. Signing of E/N
2. Signing of G/A
5. Verification
3. Open Account B/A
7. Issue of A/P
6. Send verified contract
4 . Contract
8. Notification of A/P
9. Request for Payment
10.Request for Paying
11. Payment
12. Payment

Project Implementation Schedule



Annex-8

Major Undertakings to be taken by Each Government

Major Undertakings to be taken by Recipient Government

1. Before the Tender

NO	Items	Deadline	In charge	Cost Estimated (USD)	Ref.
1	To obtain the approval of IEE	before the Project approval by Japanese Cabinet	APORTIL		
2	To open Bank Account (Banking Arrangement (B/A))	within 1 month after G/A	MPWTC		
3	To secure lands 1) temporary construction yard and stock yard near the Project area 2) borrow pit and disposal site near the Project area	within 1 month after G/A	APORTIL		
4	To obtain the planning, zoning, building permit	before tender notice	APORTIL		
5	To clear, level and reclaim the following sites when needed	before tender notice	APORTIL		
6	To determine the plan of passenger terminal building	before tender notice	APORTIL		

2. During the Project Implementation

NO	Items	Deadline	In charge	Cost Estimated (USD)	Ref.
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A				
	1) Advising commission of A/P	within 1 month after the singing of the contract	MOF	17,200	
	2) Payment commission for A/P	every payment	APORTIL		
2	To issue the Working Visa for workers	before commencement of the Project	Ministry of Internal Affairs		
3	To construct the passenger terminal building	during the Project	APORTIL	1,036,700*1	
4	To demolish the blockage in the construction yard	before commencement of the construction work	APORTIL	19,500	
5	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country	during the Project	APORTIL		
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work	during the Project	APORTIL		
7	To bear the cost which is equivalent to the customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the Products and/or the Services, instead of tax exemption system. Such customs duties, internal taxes and other fiscal levies mentioned above include VAT, commercial tax, income tax and corporate tax of Japanese nationals, resident tax, fuel tax, but not limited, which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract	during the Project	APORTIL	72,500	
8	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the Project implementation	during the Project	APORTIL		
9	To submit environmental monitoring report to JICA Timor-Leste Office	during the Project	APORTIL		

*1/ Cost of construction of passenger terminal is subject to change based on the design and BoQ (Bill of Quantity).

3. After the Project

NO	Items	Deadline	In charge	Cost Estimated (USD)	Ref.
1	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine/Periodic inspection	after completion of the construction	APORTIL	Refer to Annex-12	
2	To submit environmental monitoring report to JICA Timor-Leste Office	after completion of the construction	APORTIL		

Major Undertakings to be covered by the Grant Aid

No	Items	Deadline	Cost Estimated (Million Japanese Yen)	Ref.
1	To construct ferry terminal jetty and necessary facilities (or To procure equipment)	Before end of contract	1,999	
	- Improvement of ferry terminal jetty			
	- Improvement of necessary facilities			
	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country			
	a) Marine(Air) transportation of the products from Japan to the recipient country			
	b) Internal transportation from the port of disembarkation to the project site			
2	To implement detailed design, tender support and construction supervision (Consultant)	Before end of contract	132	

Project Monitoring Report
on
Project Name
Grant Agreement No. XXXXXXX
20XX, Month

Organization Information

Authority (Signer of the G/A)	Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Executing Agency	Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Line Agency	Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____

Outline of Grant Agreement:

Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____
Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:

1: Project Description

1-1 Project Objective

1-2 Necessity and Priority of the Project

- Consistency with development policy, sector plan, national/regional development plans and demand of target group and the recipient country.

1-3 Effectiveness and the indicators

- Effectiveness by the project

Quantitative Effect (Operation and Effect indicators)		
Indicators	Original (Yr)	Target (Yr)
Qualitative Effect		

2: Project Implementation

2-1 Project Scope

Table 2-1-1a: Comparison of Original and Actual Location

Location	**Original:** *(M/D)* **Attachment(s):Map**	**Actual:** *(PMR)* **Attachment(s):Map**

Table 2-1-1b: Comparison of Original and Actual Scope

Items	Original	Actual
(M/D)	*(M/D)*	*(PMR)* Please state not only the most updated schedule but also other past revisions chronologically. All change of design shall be recorded regardless of its degree.

2-1-2 Reason(s) for the modification if there have been any.

(PMR)

2-2 Implementation Schedule

2-2-1 Implementation Schedule

Table 2-2-1: Comparison of Original and Actual Schedule

Items	Original		Actual
	DOD	G/A	
[M/D] 'Soft component' shall be stated in the column of 'Items'. Project Completion Date*	*(M/D)*		*(PMR)* As of (Date of Revision) Please state not only the most updated schedule but also other past revisions chronologically.

*Project Completion was defined as _____ at the time of G/A.

2-2-2 Reasons for any changes of the schedule, and their effects on the project.

2-3 Undertakings by each Government

2-3-1 Major Undertakings

See Attachment 2.

2-3-2 Activities

See Attachment 3.

2-4 Project Cost

2-4-1 Project Cost

Table 2-4-1a Comparison of Original and Actual Cost by the Government of Japan
(Confidential until the Tender)

Items			Cost (Million Yen)	
	Original	Actual	Original	Actual
Construction Facilities (or Equipment)	'Soft component' shall be included in 'Items'.			Please state not only the most updated schedule but also other past revisions chronologically.
Consulting Services	- Detailed design -Procurement Management -Construction Supervision			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

Table 2-4-1b Comparison of Original and Actual Cost
by the Government of Sri Lanka

Items			Cost (Million USD)	
	Original	Actual	Original	Actual
				Please state not only the most updated schedule but also other past revisions chronologically.
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = (local currency)

2-4-2 Reason(s) for the wide gap between the original and actual, if there have been any, the remedies you have taken, and their results.

(PMR)

2-5 Organizations for Implementation

2-5-1 Executing Agency:

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original: *(M/D)*
Actual, if changed: *(PMR)*

2-6 Environmental and Social Impacts

- The results of environmental monitoring as attached in Attachment 5 in accordance with Schedule 4 of the Grant Agreement.
- The results of social monitoring as attached in Attachment 5 in accordance with Schedule 4 of the Grant Agreement.
- Information on the disclosed results of environmental and social monitoring to local stakeholders, whenever applicable.

3: Operation and Maintenance (O&M)

3-1 O&M and Management

- Organization chart of O&M
- Operational and maintenance system (structure and the number ,qualification and skill of staff or other conditions necessary to maintain the outputs and benefits of the project soundly, such as manuals, facilities and equipment for maintenance, and spare part stocks etc)

Original: *(M/D)*
Actual: *(PMR)*

3-2 O&M Cost and Budget

- The actual annual O&M cost for the duration of the project up to today, as well as the annual O&M budget.

Original: *(M/D)*

4: Precautions (Risk Management)

- Risks and issues, if any, which may affect the project implementation, outcome, sustainability and planned countermeasures to be adapted are below.

Original Issues and Countermeasure(s): *(M/D)*	
Potential Project Risks	Assessment
1.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
2.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:

	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
3.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
Actual issues and Countermeasure(s)	
(PMR)	

5: Evaluation at Project Completion and Monitoring Plan

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan for the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Undertakings to be taken by each Government
3. Monthly Report
4. Environmental Monitoring Form / Social Monitoring Form
5. Monitoring sheet on price of specified materials
6. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
   (Final Report Only)

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1. Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) N (d) N	(a) It is assumed that APORTIL will prepare EIS (Category A Project) or SEIS (Category B Project) by end of April 2016. (b) APORTIL will proceed and Environmental License will be issued by the end of June 2016. (c) EIS/SEIS meets the requirements of NDE, therefore, any collateral condition may not be required. (d) Permit for construction works will be prepared by APORTIL and obtained by the commencement of the construction work.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) N (b) N	(a) It is assumed that this project will be classified as Category B Project, therefore, the public consultation to be held at the stage of SEIS and EMP is not mandatory. APORTIL will discuss with NDE on the Public Consultation to be held or not. After NDE will review the SEIS and EMP, then NDE may require to hold the public consultation. (b) Comments and opinion collected at Public Consultation will be replied by APORTIL and those comments will be taken into account, if necessary.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental	(a) Y	(a) Review of alternative plans including environmental and social considerations matter has already carried out.

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		considerations?		
2. Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted from ships, vehicles and project equipment comply with the country's emission standards? Are any mitigating measures taken?	(a) Y	(a) Field survey was conducted prior to the commencement of construction work, all items clear the criteria. During construction and operation, number of vessels and vehicles will be increased, however, the impact to air quality is minimal. During construction, water splay and tire cleaning facility will be provided and inspection and maintenance of engines for vessels and vehicles will be conducted for the improvement of exhausted gas quality.
	(2) Water Quality	(a) Do effluents from the project facilities comply with the country's effluent and environmental standards? (b) Do effluents from the ships and other project equipment comply with the country's effluent and environmental standards? (c) Does the project prepare any measures to prevent leakages of oils and toxicants? (d) Does the project cause any alterations in coastal lines and disappearance/appearance of surface water to change water temperature or	(a) Y (b) Y (c) Y (d) N	(a) Related facility (passenger terminal building) will be constructed and sewerage facility and rainwater drainage which meet the environmental quality standard will be provided. Present water quality clear the standard of Indonesia because local environmental quality standard has not been issued yet. (b) Timor-Leste does not have own quality standard for discharge water and water quality, however, MARPOL (Annex IV), Marine Pollution Prevention Act 2008 and other international agreements are applied. (c) Fuel supply to working vessels and construction machine will be conducted in accordance with the requirements of working procedural manual and project contractor must prepare the action plan for oil spill. (d) Reclamation is not necessary, and the jetty and platform

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		quality by decrease of water exchange or changes in flow regimes? (e) Does the project prepare any measures to prevent polluting surface, sea or underground water by the penetration from reclaimed lands?	(e) N	is supported by steel pipe piles and concrete piles, therefore, seawater exchange will not occur. (e) Reclamation is not necessary.
	(3) Wastes	(a) Are wastes generated from the ships and other project facilities properly treated and disposed of in accordance with the country's regulations? (b) Is offshore dumping of dredged soil properly disposed in accordance with the country's regulations? (c) Does the project prepare any measures to avoid dumping or discharge toxicants?	(a) Y (b) Y (c) Y	(a) Wastes are collected by APORTIL and disposed of at public landfill. (b) In case dredging work is necessary, pollution prevention membrane must be installed to prevent spreading muddy water. Dredged material must be dumped at authorized offshore dumping area. (c) It is not planned that any hazardous substance is used. In case hazardous substance is used in this project, project contractor must prepare the procedural manual for handling hazardous substance and the operation must be carried out according to the procedural manual.
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a) Y	(a) Level of noise and vibration clear the Indonesian criteria because Timor-Lest does not have local criteria. Japanese criteria is used for forecasting the level of noise and vibration during piling work.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the	(a) N	(a) Groundwater is not pumped up.

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		extraction of groundwater will cause subsidence?		
	(6) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) Y	(a) In case dredging work is necessary, dredged material may generate bad smell. If the bad smell is tremendous, some measure to neutralize ammonia is taken.
	(7) Sediment	(a) Are adequate measures taken to prevent contamination of sediments by discharges or dumping of hazardous materials from the ships and related facilities?	(a) Y	(a) MARPOL (Annex IV), Marine Pollution Prevention Act 2008 and Waste Management Act 2010 are applied, therefore, vessels and related facilities do not dispose/dump pollutant to the seawater.
3. Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) Protected area does not exist around the proposed project area.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?	(a) N	(a) There are not primary forest, tropical natural forest, important habitat of coral, mangrove, wetland, tidal wetland, etc. around the project site, however, coral which is classified as Near Threatened (NT) is found at the area about 1,000 meters to north from the project site, and countermeasures to prevent giving impact due to construction work on the coral above must be provided.
		(b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?	(b) N	(b) There is not any important habitat for precious species around project site.
		(c) If significant ecological impacts are	(c) Y	(c) There is no concern to give impact on ecological system, however, visual observation must be conducted to find any

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	(d) Y	spreading of muddy water. When working vessel will be imported from foreign country, ship bottom cleaning prior to the mobilization and verification upon arrival must be carried out to prevent adventive to come in.
		(d) Is there a possibility that the project will adversely affect aquatic organisms? Are adequate measures taken to reduce negative impacts on aquatic organisms?	(e) N	(d) Ditto above
		(e) Is there a possibility that the project will adversely affect vegetation or wildlife of coastal zones? If any negative impacts are anticipated, are adequate measures taken to reduce the impacts on vegetation and wildlife?		(e) No impact will be given to coastal vegetation and wild animals.
	(3) Hydrology	(a) Do the project facilities affect adversely flow regimes, waves, tides, currents of rivers and etc. if the project facilities are constructed on/by the seas?	(a) N	(a) Jetty and platform are supported by steel pipe piles and concrete piles, therefore, ferry mooring facility does not give negative impact on flow condition, wave and tidal current.
	(4) Topography and Geology	(a) Does the project require any large scale changes of topographic/geographic features or cause disappearance of the natural seashore?	(a) N	(a) Change of topography and geology and cease of natural seashore will not occur.
4. Social	(1) Resettlement	(a) Is involuntary resettlement caused by project	(a) N	(a) to (j) No land acquisition nor involuntary resettlement

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
Environment		implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?		occur because the project area is under the control of APORTIL.
		(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?	(b) N	
		(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?	(c) N	
		(d) Are the compensations going to be paid prior to the resettlement?	(d) N	
		(e) Are the compensation policies prepared in document?	(e) N	
		(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?	(f) N	
		(g) Are agreements with the affected people obtained prior to resettlement?	(g) N	
		(h) Is the organizational framework established to properly implement resettlement? Are the	(h) N	
			(i) N	

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(j) N	
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(a) Y	(a) During construction work, vehicles for construction work may impact the traffic of surrounding area, however, the number of vehicle is not many and level of impact is minor. Work schedule is informed on ahead to the surrounded residents.
		(b) Is there a possibility that changes in water uses (including fisheries and recreational uses) in the surrounding areas due to project will adversely affect the livelihoods of inhabitants?	(b) N	(b) There is no impact on the usage of water area.
		(c) Is there a possibility that port and harbor facilities will adversely affect the existing water traffic and road traffic in the surrounding areas?	(c) Y	(c) Same as (a)
		(d) Is there a possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are considerations given to public health, if necessary?	(d) N	(d) Any population inflow is not expected due to this project.

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no legacy nor historical places around the project site.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) The area for this project is within the existing port area, therefore, it is assumed that the project has no negative impact on the landscape.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	(a) and (b) The ethnic minority and indigenous people does not exist around the project area and the fishery rights does also not exist because the project area locates within the existing port area.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?	(a) Y	(a) Local regulations are observed.
		(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?	(b) Y	(b) Safety measures, such as wearing life jackets (when working on the sea) and installing life float, safety fence and caution sign are planned.
		(c) Are intangible measures being planned and	(c) Y	(c) It is planned to provide the safety and health training to

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(d) Y	workers, including the safety and health of workers and respecting the local society. (d) Employment of local people must be prioritized and workers must be educated for respecting local culture.
5. Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) N (c) N	(a) Construction volume must be minimized. Monitoring must be carried out for dust, noise, vibration, exhaust gas, muddy water, etc. by instrument measurement and visual observation daily, and impact to the surrounding area must be verified. (b) It is not assumed that any work generating pollution is implemented, however, monitoring to verify the generation of pollution can minimize the negative impact on natural environment. The construction work has minimal impact on natural environment. Natural environment other than pollution has no negative impact. (c) Increase of number of vehicles during the construction work is low, however, interview to the surrounding residents must be carried our periodically in order to

Environmental Checklist : 10. Ports and Harbors

Category	Environmental Item	Main Check Items	Yes: Y No : N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				understand the situation and make the negative impact minimal.
	Note on Using Environmental Checklist	(a) Where necessary, impacts on groundwater hydrology (groundwater level drawdown and salinization) that may be caused by alteration of topography, such as land reclamation and canal excavation should be considered, and impacts, such as land subsidence that may be caused by groundwater uses should be considered. If significant impacts are anticipated, adequate mitigation measures should be taken. (b) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N (b) N	(a) It is not assumed that the project has impact on groundwater system (lowering of water level and salination) and ground settlement due to usage of groundwater. (b) The project lies at northern side and central part of the island of Timor-Leste, it is not assumed that the impact caused by the project has cross-border impact.

MONITORING FORM (Before and during construction work)

1. Responses/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
Responses/Actions to Comments and Guidance from Government Authorities	
Number and contents of comments made by stakeholders	
Number and contents of responses made by project proponent	

2. Mitigation Measures

Air Quality, Ecological System

Schedule	Condition of air quality, dust, ecological system, etc. by visual observation	Judgement, countermeasure
1st day		
2nd day		
3rd day		
. .		

In case any unusual situation of air quality is identified during visual observation, the following quality survey is implemented.

- Air Quality (Emission Gas / Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
SO_2	$\mu g/Nm^3$	max.365/24hours	max.900/hour	N.A.	Indonesia	
NO_2	$\mu g/Nm^3$	max.150/24hours	max.400/hour	N.A.	Indonesia	
CO	$\mu g/Nm^3$	max.10,000 /24hours	max.30,000 /hour	N.A.	Indonesia	
O_3	$\mu g/Nm^3$	-	max.235/hour	N.A.	Indonesia	

Dust (TSP)	μg/Nm^3	max.230/24hours	-	N.A.	Indonesia	
HC	μg/Nm^3	max.160/3hours		N.A.	Indonesia	
Pb	μg/Nm^3	max.2/24hours	-	N.A.	Indonesia	

Water Quality (by Visual Observation)

Schedule	Rain fall	Condition of water pollution	Condition of rain fall and drainage	Judgement, countermeasure
1st day	yes/no			
2nd day	yes/no			
3rd day	yes/no			
.				

In case any unusual situation of water quality is identified during visual observation, the following quality survey is implemented.

Water Quality

Schedule	Item	Unit	Sample -1	Sample -2	Sample -3	Sample -4	Sample -5	*Criteria	Adjudication
1st day	Turbidity	NTU						Max. 5	
	pH	-						7-8.5	
(Date)	Total nitrogen	mg/L						0.1	
	Total phosphate	mg/L						0.015	
	COD	mg/L						-	
	Oil & grease	mg/L						-	
	Total suspended solids	mg/L						Max. 20	
3rd day	Turbidity	NTU						Max. 5	
	pH	-						7-8.5	
(Date)	Total nitrogen	mg/L						0.1	
	Total phosphate	mg/L						0.015	
	COD	mg/L						-	
	Oil & grease	mg/L						-	
	Total suspended solids	mg/L						Max. 20	
5th day	Turbidity	NTU						Max. 5	
	pH	-						7-8.5	
(Date)	Total nitrogen	mg/L						0.1	
	Total phosphate	mg/L						0.015	
	COD	mg/L						-	
	Oil & grease	mg/L						-	
	Total	mg/L						Max. 20	

Schedule	Item	Unit	Sample -1	Sample -2	Sample -3	Sample -4	Sample -5	*Criteria	Adjudica-tion
	suspended solids								
7th day (Date)	Turbidity	NTU						Max. 5	
	pH	-						7-8.5	
	Total nitrogen	mg/L						0.1	
	Total phosphate	mg/L						0.015	
	COD	mg/L						-	
	Oil & grease	mg/L						-	
	Total suspended solids	mg/L						Max. 20	

*:Indonesian criteria are applied because Timor-Leste's criteria have not been issued.

Waste (within construction area)

Schedule	Contents	Quantity (m^3)	Disposal method
1st day			
2nd day			
3rd day			
. .			

Soil pollution

Schedule	Description of work	Yes/No of soil pollution	Mitigation method
1st day			
2nd day			
. .			

Noise / Vibration

Item (unit)	Measured value (average)	Measured value (max)	Local standard	International standard referred	Frequency (during piling work)	Method	Measuring point
Noise level (dB)			NA	80 (7AM-7PM)	10 min. Twice/day	Noise level meter	Border of lot
Vibration level (dB)			NA	70 (7AM-7PM)		Vibration meter	Border of lot

Note : Japanese standard of Ministry of Land, Infrastructure, Transport and Tourism is

referred as International standard for noise and vibration.

Odor

Schedule	Description of work	Yes/No of odor	Mitigation method
1st day			
2nd day			
. .			

3. Natural Environment

- Ecosystem

Monitoring Item	Monitoring Results during Report Period
Negative effects/Actions to Valuable species	To be carried out together with Air Quality visual observation

4. Social Environment

Monitoring item	Item	Method	Frequency	Condition during reporting period
Resettlement	Not Applicable			
Livelihood	Traffic jam, noise, vibration	Visual observation and hearing	Once/week	
Working environment	Implementation status of management of safety and health	Verification of monthly	Once/month	
Accident	Implementation status of management of safety and health	Verification of monthly accident report	Once/month	

MONITORING FORM (During operation)

1. Responses/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
Responses/Actions to Comments and Guidance from Government Authorities	
Number and contents of comments made by stakeholders	
Number and contents of responses made by project proponent	

2. Social environment

Monitoring item	Item	Method	Frequency	Condition during reporting period
Accident	Implementation status of management of safety and health, Safe traffic line of passengers	Verification of monthly accident report	Once/month	

Operation and Maintenance Cost

Item	Yearly Maintenance Cost	Periodical Maintenance Cost	Incidental Investment Cost
Overall Facilities	US$3,600		
Jetty, Platform		US10,000/3 year	Concrete repair cost
Movable Ramp		US$5,200/2 year	Repair cost for structural damage
Rubber Fender			US$25,000/set (when damaged)
Bollard	US$100		
Navigation Aids			
Lighting facility			US$70/lamp (change)
Water supply & Hydrant	US$100		
CCTV System			US$50/No. (Camera) US$200/No. (Monitor) US$450/set (DC power source) (all for replace)
TOTAL	**US$3,800**		

5. 参考資料

5-1　フェリー利用者ヒアリング調査結果

5-1-1　調査概要

ナクロマ利用客に対して下記の内容でヒアリング調査を実施した。

① 日　時：2015 年 7 月 21 日（月）　13:00～17:00
② 場　所：ディリ港東側ゲート付近
③ ヒアリング人数：100 名
④ ヒアリング項目：表 5-1 に示すヒアリング調査シートを作成して実施した。

表 5-1　ヒアリング調査シート

ディリ港フェリーターミナル利用者（ディリ⇒オエクシ間）調査表　—Japanese—

性　別	□男　□女	年齢		国籍	□東ティモール □インドネシア □その他(　　)
住　所	□ディリ　□オエクシ □その他(　　)			職業	□学生　□会社員 □自営業　□農業 □その他(　　)
利用目的	□仕事　□商用　□帰郷　□買い物 □旅行　□その他(　　)			同伴者 見送り	名 名
自動車利用か？	□YES　□NO	自動車の種類	□乗用車　□トラック　□オートバイ □その他(　　)		
積荷の種類	□食料品　□衣料品　□日用雑貨　□学用品　□医薬品　□嗜好品 □その他(　　)				
1ヶ月当たりの利用回数	□１回　□２回　□３回　□４回　□５回以上(　　回)				
乗船に問題はないか？	□YES　□NO				
どの様な時が問題か？	□チケット購入が難しい。　□チケット購入に時間がかかる。 □乗船までの待合場所がない。 □乗船までにどのくらい時間がかかるか？(　　時間) □運行時間の遅延 □その他 (　　)				
危険を感じたことはあるか？	□YES　□NO				
どの様な時か？	□乗船までの通路　□ランプウェイからの乗り込み時 □自動車の運行　□コンテナの荷役機械 □その他 (　　)				
フェリーターミナルにあってほしい設備はあるか？	□待合室　□洗面所　□売店　□公衆電話　□食堂　□授乳室　□遊戯施設 □駐車場　□バイク置場　□出発、到着時間掲示板 □その他 (　　)				
その他、要望はあるか？					

5-1-2　調査結果

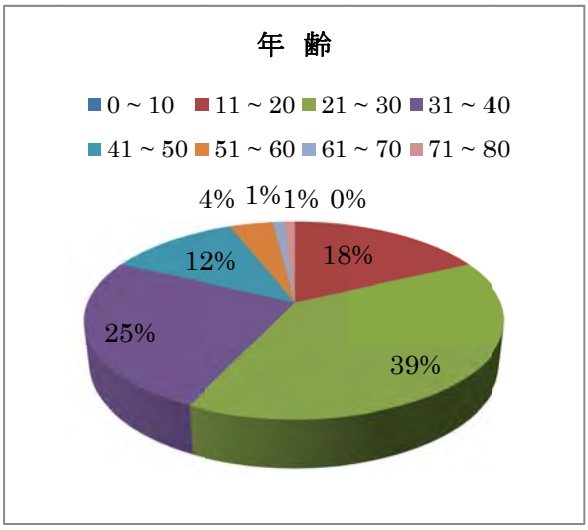
ヒアリング調査結果をグラフ化して、図 5-1～5-2 に示す。

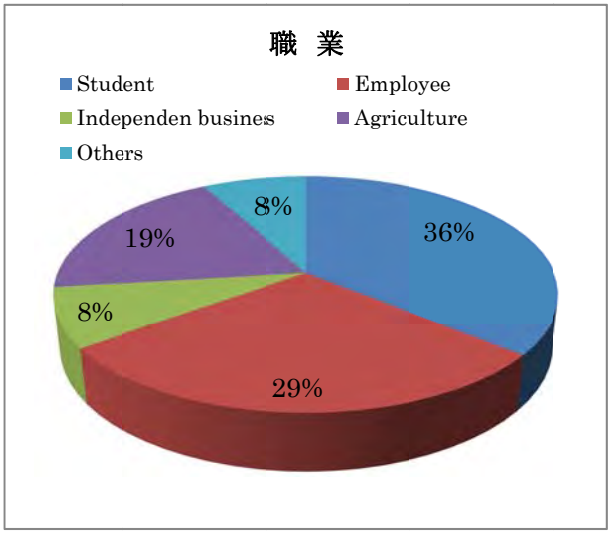
ナクロマ利用者の年齢は、21～23 歳が約 40%を占め、国籍はほぼ東ティモールでありディリかオエクシの住居者が利用している。利用者の職業は、学生、会社員及び農業の順となっている。利用目的は、帰郷が約 40%を占め、旅行、仕事の順となっている。同伴人数は、1～3 人が過半数をしめている。見送り人数は、過半数がなしで、1～3 人程度である。モーターバイク利用者は、全体の 25%で、1ヶ月当たりの利用回数は、1～2 回が約 85%である。

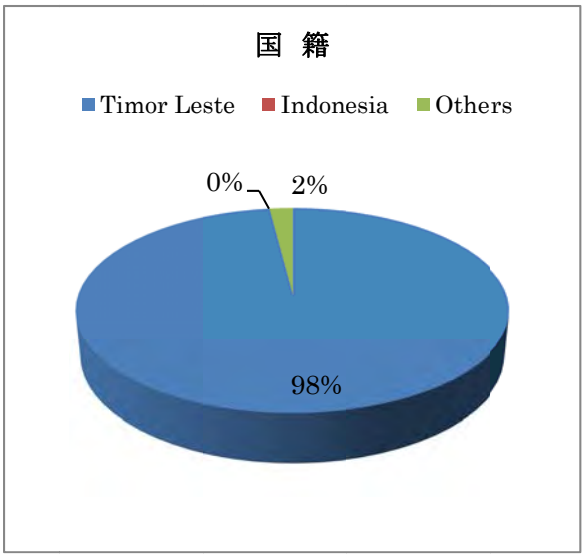
乗船時の問題点は、約 80%の人が問題ありと回答しており、待合室がない点とチケット購入の難しさをあげている。乗船時に感じる危険としては、乗船までの通路、ランプウェイからの乗り込み時及び自動車の通行をあげている。また、フェリーターミナルへの要望施設は、待合室、出発・到着時間掲示板、洗面所、食堂及び授乳室の整備の要望が多い。

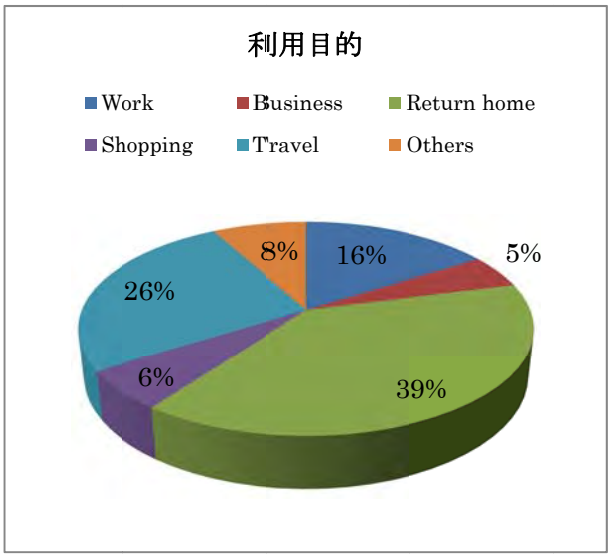
その他の回答の得られた要望を下記に示す。

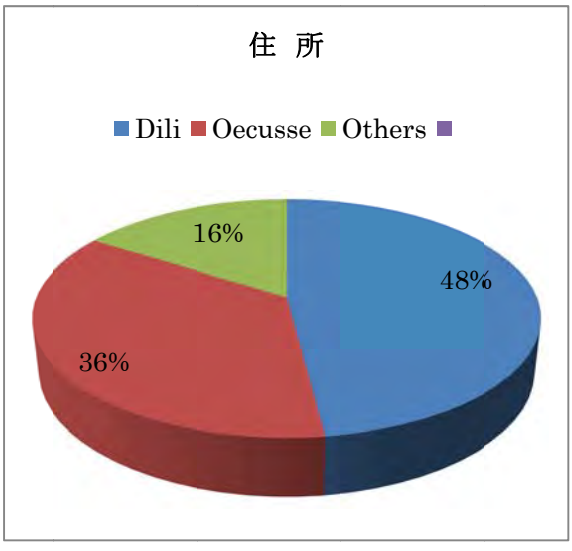
・質の高い新しい港湾を建設して、施設、スタッフを増やして、健康のための良い環境が非常に重要です。
・小さな庭を組み入れた快適な空間を創って下さい。
・旅客需要が現在非常に多いので、必要に応じて、フェリーをもう 1 隻建造して下さい。
・緊急事態に対応する、応急手当の為に治療とスタッフのためにスペースを確保して下さい。
・船内の混雑、狭い車道と待合室がないことが問題です。
・フェリーの運行と乗客が満足する様な、質の高い新しい港を建設して下さい。
・スタッフを増員すれば、乗客は彼らから情報を簡単に得られます。コンテナの一時置場としてターミナル地域を使わないで下さい。
・施設を増やして、良いシステムを構築して下さい。
・施設を増やして下さい。そして、安全装置システムを含む港湾システムは、国際標準でなければなりません。
・可能であれば、オエクシ港と同じ様な新しい港湾を建設して下さい。そして、オエクシ港と同様な駐車場システムを造ってください。
・新しい港湾とフェリーターミナビルディングを作って下さい。そして、フェリーをもおう 1 隻加えて下さい。
・港湾施設とターミナル設備を増やして、すべての乗客の為のスペースを確保して下さい。
・港湾施設（例えば乗降客用ターミナルと駐車場）を建設することを、国際社会に問います。
・コンテナ置き場と分離した待合室を含むすべての港湾港施設を増やしてください。











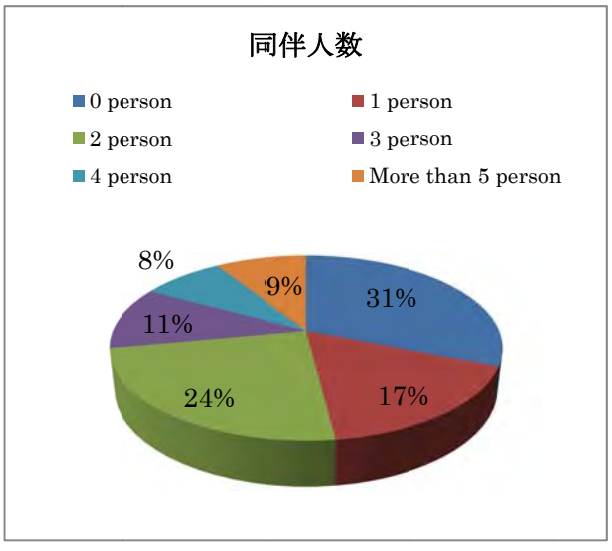
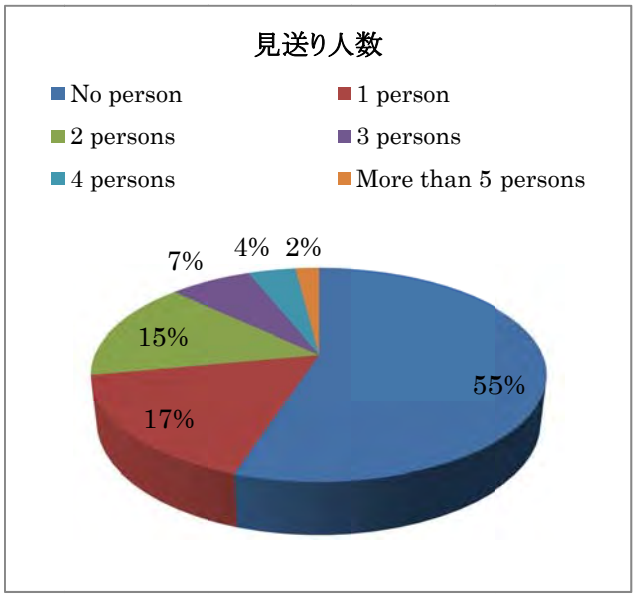
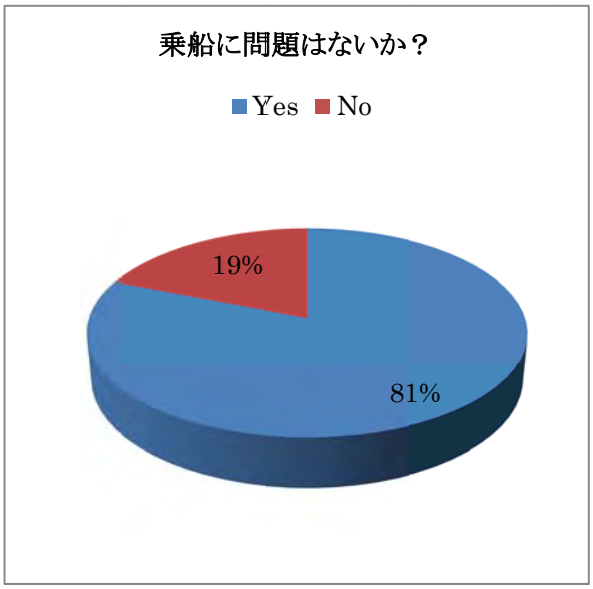
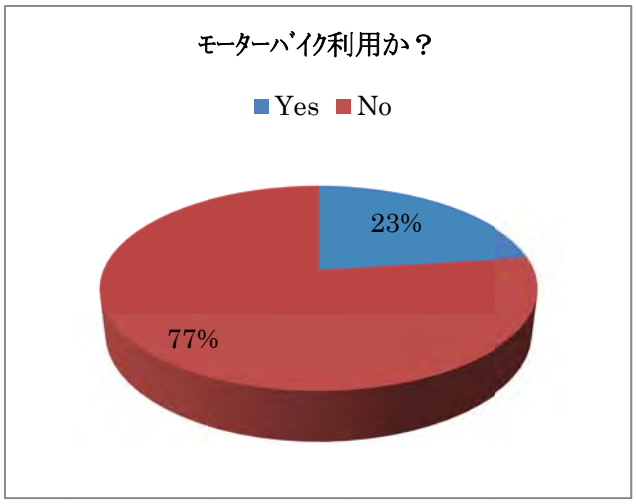
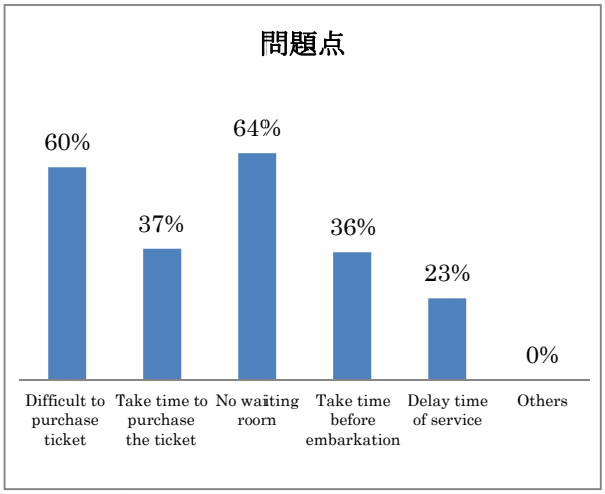


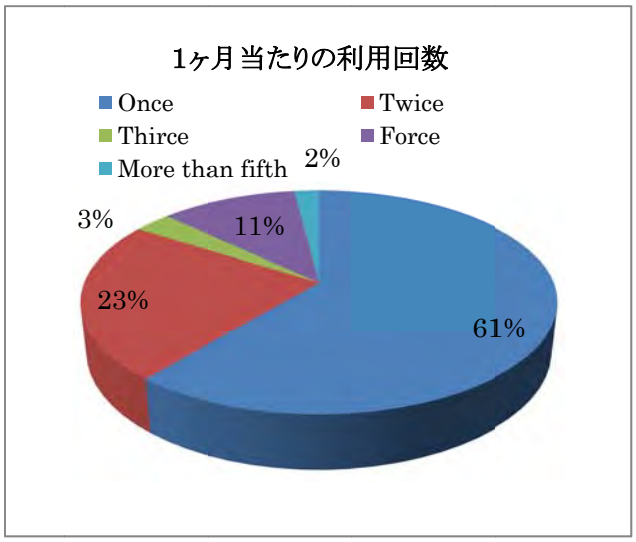
図 5-1　ヒアリング調査結果(1)











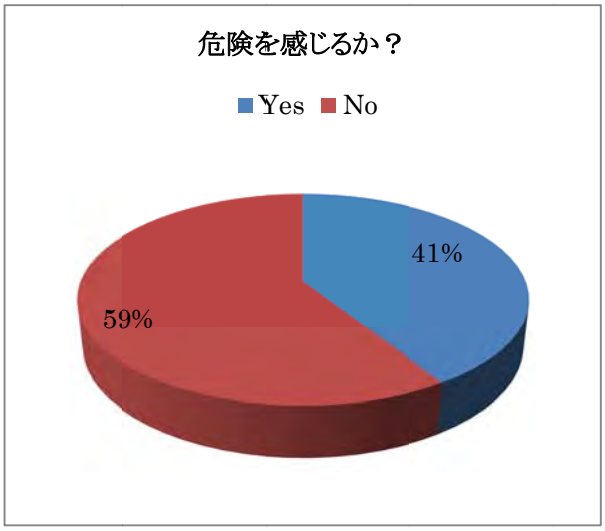
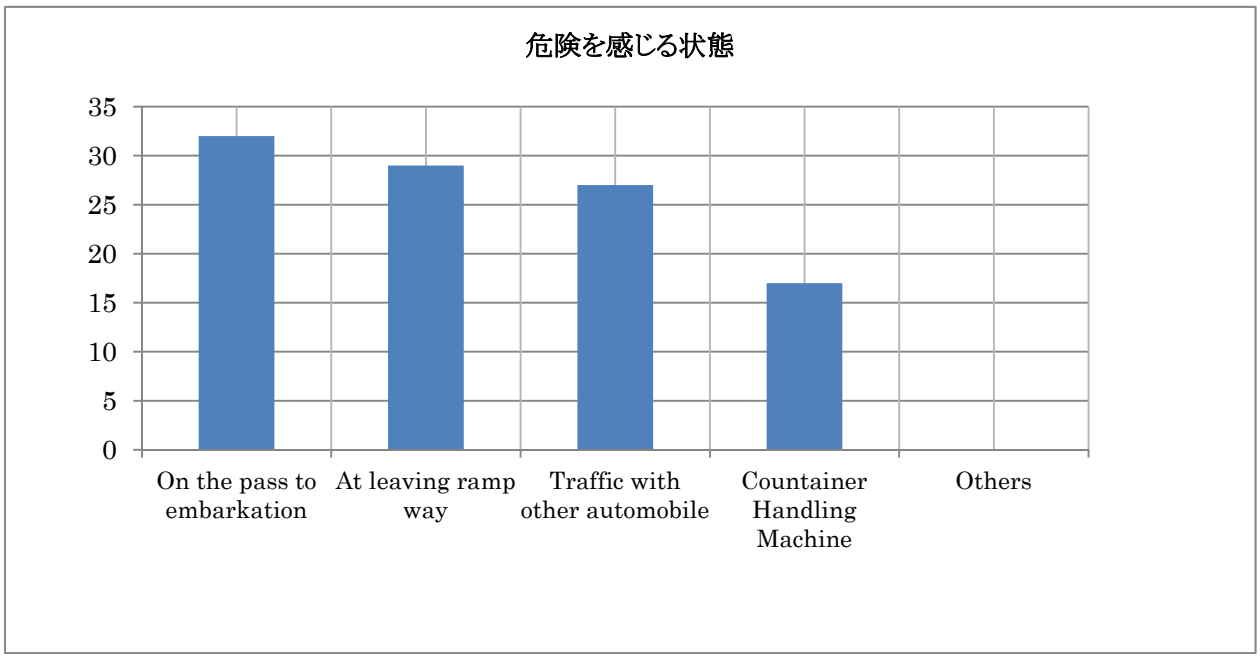


図 5-1　ヒアリング調査結果（2）



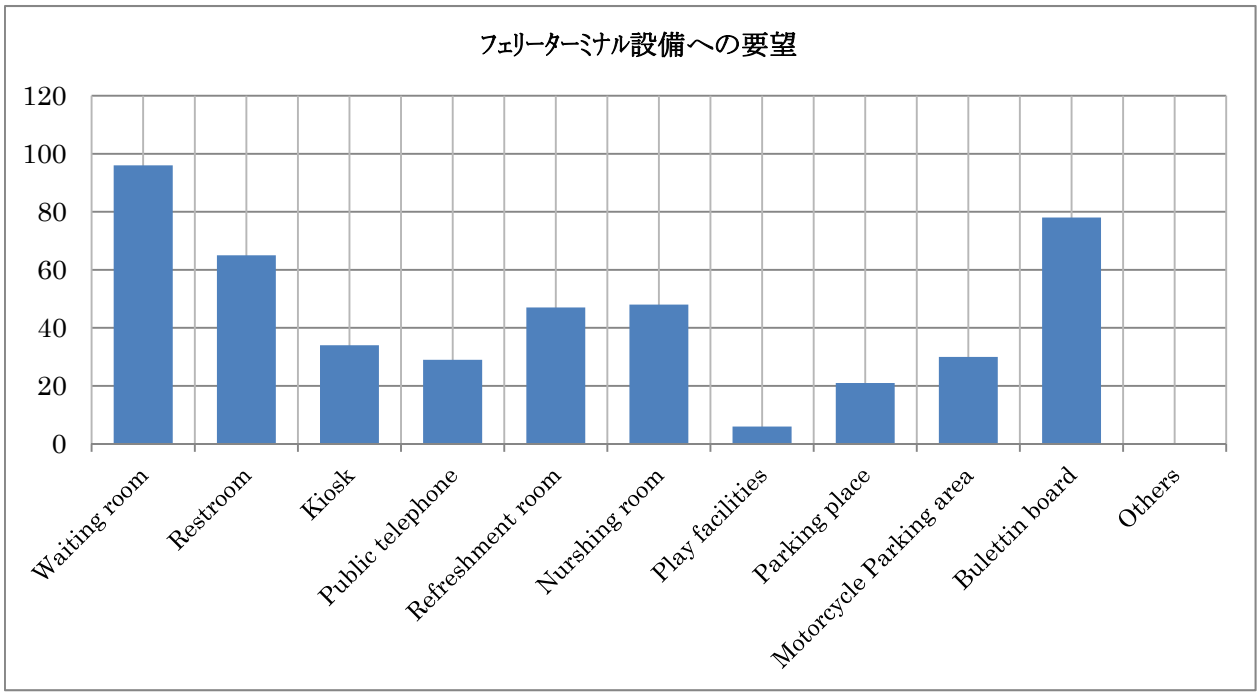


図 5-2　ヒアリング調査結果

ナクロマ係留状況

モーターバイク乗船状況

ゲート外待機状況

ゲート付近乗船券確認状況

ヒアリング状況(1)

旅客ゲート内徒歩状況

ヒアリング状況(2)

旅客乗船状況

調査時写真

Annex 1

表-1　性　別

性　別	
男	42 人
女	58 人
合計	100 人

表-2　年 齢

年　齢	
0～10 歳	0 人
11～20 歳	18 人
21～30 歳	39 人
31～40 歳	25 人
41～50 歳	12 人
51～60 歳	4 人
61～70 歳	1 人
71～80 歳	1 人
合　計	100 人

表-3　国　籍

国　籍	
東ティモール	98 人
インドネシア	0 人
その他	2 人
合　計	100 人

表-4　住　所

住　所	
ディリ	48 人
オエクシ	36 人
その他	16 人
合　計	100 人

表-5　職　業

職　業	
学　生	36 人
会社員	29 人
自営業	8 人
農業	19 人
その他	8 人
合　計	100 人

表-6　利用目的

利用目的	
仕　事	16 人
商　用	5 人
帰　郷	39 人
買い物	6 人
旅　行	26 人
その他	8 人

表-7　同伴者人数

同伴者人数	
なし	31 人
1人	17 人
2人	24 人
3人	11 人
4人	8 人
5人以上	9 人
合　計	100 人

表-8　見送り人数

見送り人数	
なし	55 人
1 人	17 人
2 人	15 人
3 人	7 人
4 人	4 人
5 人以上	2 人
合　計	100 人

表-9　自動車利用

自動車利用	
はい	23 人
いいえ	77 人
合　計	100 人

表-10　1ヶ月当たりの利用回数

1ヶ月当たりの利用回数	
1 回	61 人
2 回	23 人
3 回	3 人
4 回	11 人
5 回以上	2 人
Total	100 人

表-11　乗船時の問題点

乗船時の問題点	
ある	81 人
ない	19 人
合　計	100 人

表-12　乗船時の問題点

乗船時の問題点	
チケット購入が難しい	60 人
チケット購入に時間がかかる	37 人
乗船までの待合室がない	64 人
乗船までに時間がかかる	36 人
運行時間の遅延	23 人
その他	0 人

表-13　危険を感じるか？

危険を感じるか？	
感じる	41 人
感じない	59 人
合　計	100 人

表-14　危険を感じる状態.

危険を感じる状態	
乗船までの通路	32 人
ランプウェイからの乗り込み時	29 人
自動車の通行	27 人
コンテナの荷役機械	17 人
その他	2 人

表-15　ﾌｪﾘｰﾀｰﾐﾅﾙにあってほしい設備

ﾌｪﾘｰﾀｰﾐﾅﾙにあってほしい設備	
待合室	96 人
洗面所	65 人
売　店	34 人
公衆電話	29 人
食　堂	47 人
授乳室	48 人
遊戯施設	6 人
駐車場	21 人
モーターバイク置場	30 人
出発、到着時間掲示板	78 人
その他	0 人

5-2　波浪条件解析結果

計画地は海面擾乱が発生しやすい地形であり、十分な波浪解析を行なって設計波浪条件を設定する必要があるため、今回実施した深浅測量成果により長期間の波浪推算結果を用いて①計画する桟橋等の設計波浪の設定と②計画地での静穏度解析の検討を行なった。

① 計画対象地点の設計波浪の推算

NOAA(アメリカ海洋大気庁)（35 か年間）をもとに、計画地の設計波浪条件を解析する。検討フローを図 5-2 に示す。

② 計画対象地点での静穏度解析

5 か年間の波浪推算をもとに、設計対象フェリーの利用限界波高に係る静穏率の算定を実施する。検討フローを図 5-3 に示す。

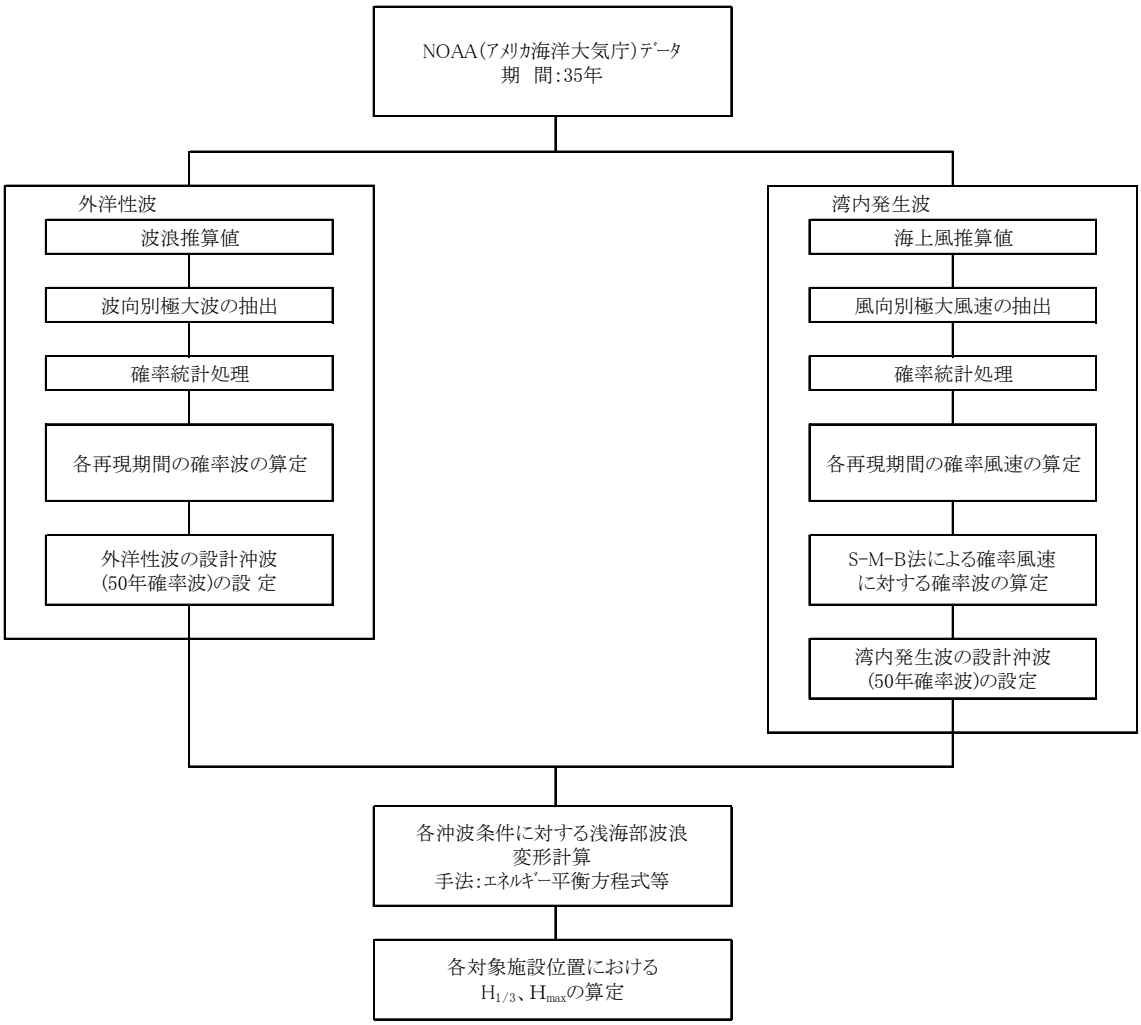


図 5-2　設計波検討フロー

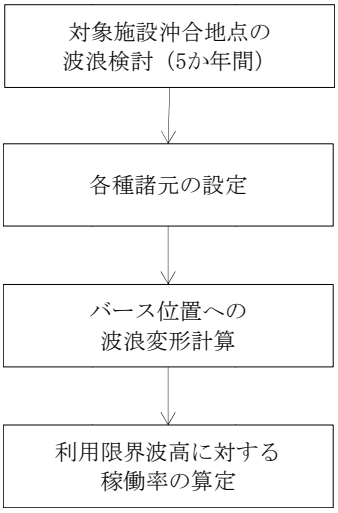


図 5-3　静穏度検討フロー

5-2-1　　波浪解析

5-2-1-1 自然条件

5-2-1-1-1　　地形・深浅測量

ディリ港付近の海図は、British Admiralty Paper Charts 942A 及び 3296 である。これらの海図を図 5-4～図 5-6 に示す。また、深浅測量の結果を図 5-7 に示す。同図によれば、海底勾配は、汀線（±0.0m）～-10.0m で急激に落ち込んでおり、1：2 程度となっている。-10.0m から沖側の海底勾配についても急で、1：10～1：20 となっている。

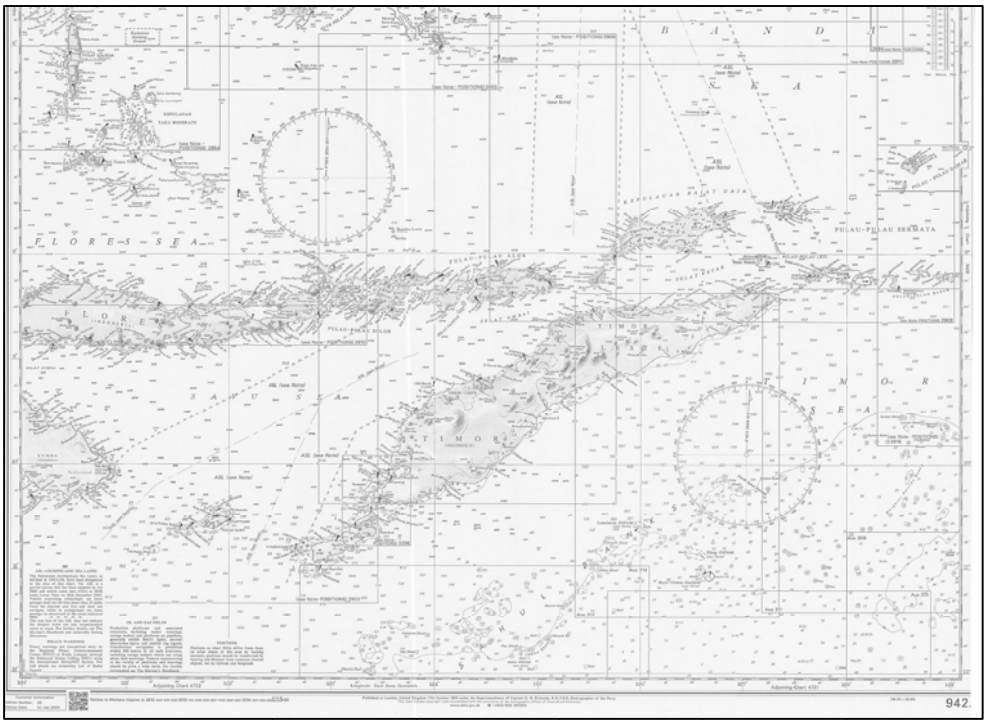


図 5-4　海図 942A（Timor 島近海抜粋）

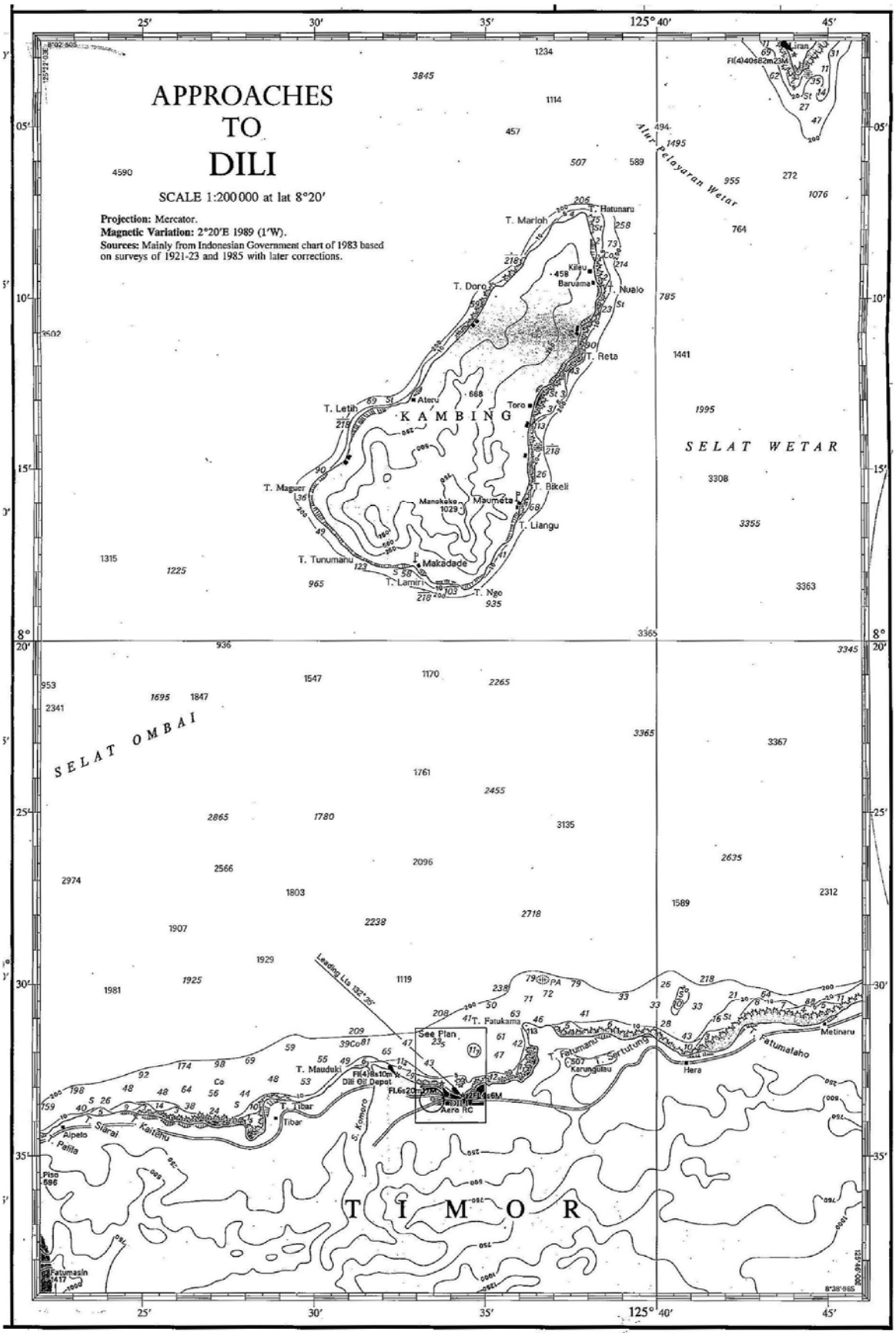

APPROACHES
TO
DILI
SCALE 1:200 000 at lat 8°20′
Projection: Mercator.
Magnetic Variation: 2°20′E 1989 (1′W).
Sources: Mainly from Indonesian Government chart of 1983 based on surveys of 1921-23 and 1985 with later corrections.
KAMBING
SELAT WETAR
SELAT OMBAI
T I M O R
Alur Pelayaran Wetar
T. Hatunaru
T. Marloh
T. Doro
Kileu
Baruama
T. Nualo
T. Reta
T. Letih
Ateru
Toro
T. Maguer
Manoksake
Maumeta
T. Bikeli
T. Liangu
T. Tunumanu
Makadade
T. Lamiri
T. Ngo
Leading Lts 192°-26′
See Plan
T. Fatukama
T. Mauduki
Dili Oil Depot
Aero RC
T. Tibar
Tibar
S. Komoro
Alpeto
Silarai
Kaitanu
Pisa
Fatumasin
Iran
Fatumalaho
Metinaru
Hera
T. Fatumanu
T. Sirtutuno
Karungilau

図 5-5　海図 3296

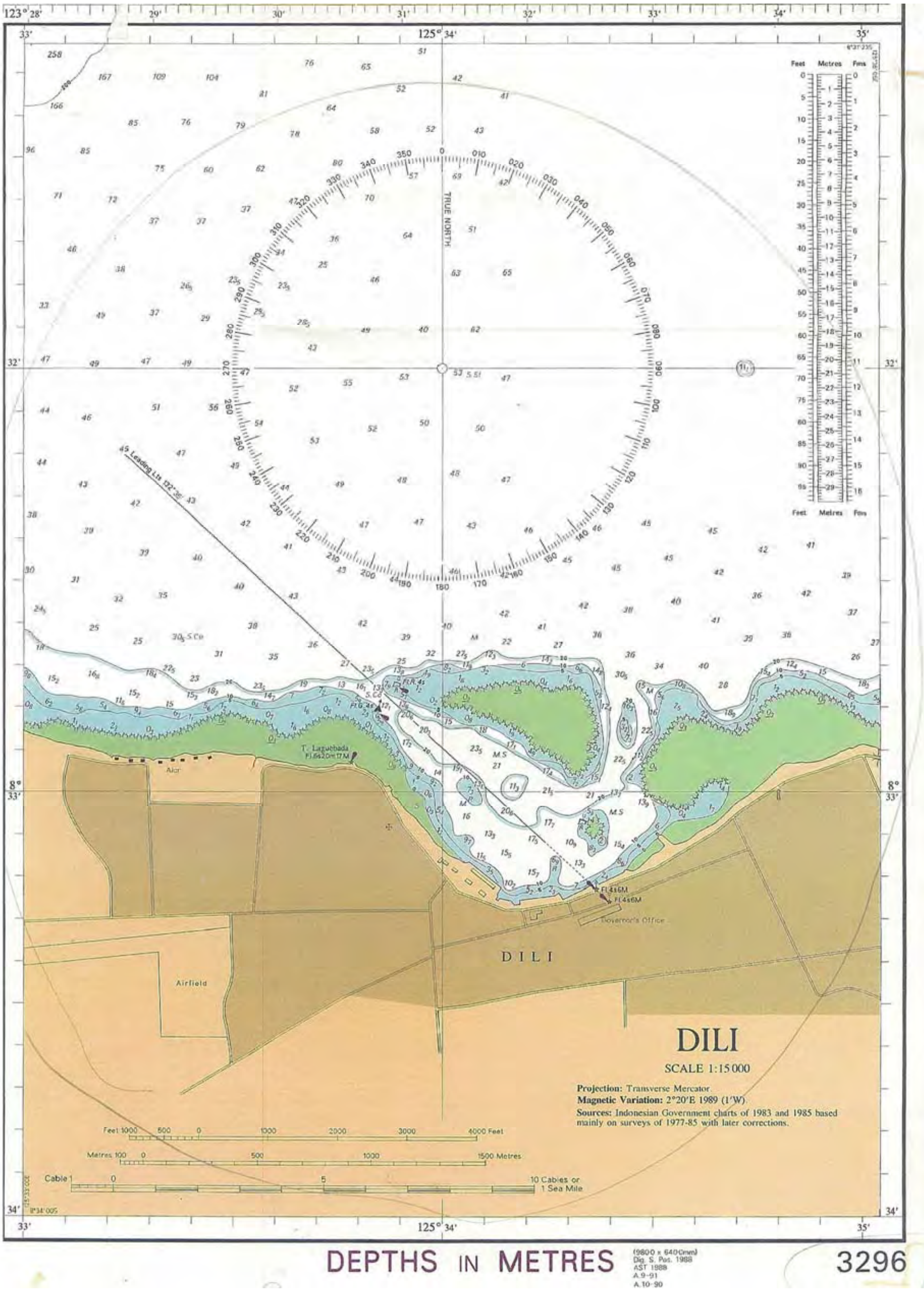
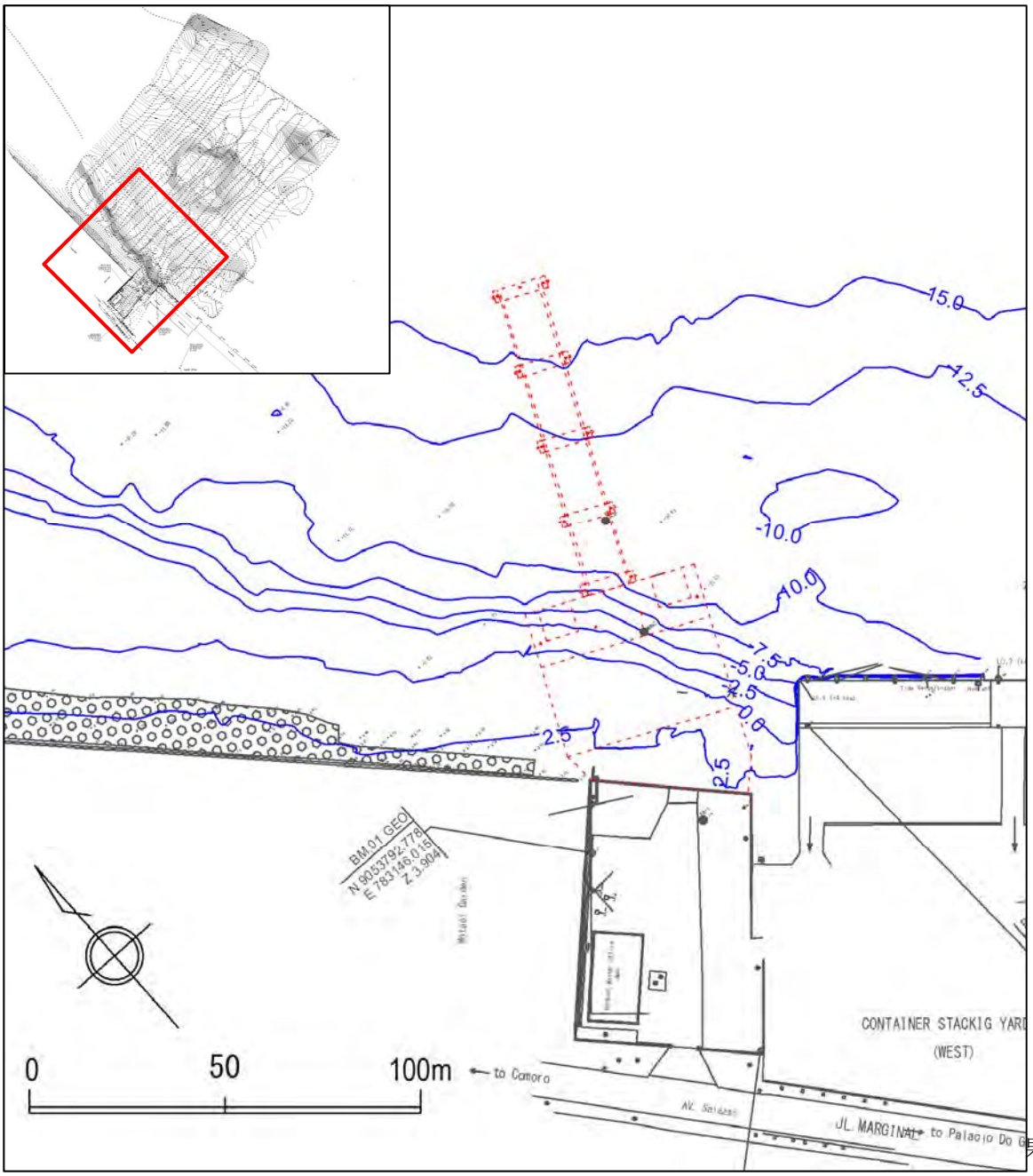

DILI
SCALE 1:15 000
Projection: Transverse Mercator.
Magnetic Variation: 2°20'E 1989 (1'W).
Sources: Indonesian Government charts of 1983 and 1985 based mainly on surveys of 1977-85 with later corrections.
Airfield
Governor's Office
TRUE NORTH
DEPTHS IN METRES
3296

図 **5-6**　**海図 3296**



果

図 5-7　地形深浅測量図及び桟橋設計予定付近の水深

5-2-1-1-2　　風

NOAA（アメリカ海洋大気局）におけるディリ港近郊の推算地点は、図 5-8 に示す通り、地点 M2（南緯 8°、東経 125.5°）及び地点 M3（南緯 8.5°、東経 125.5°）である。

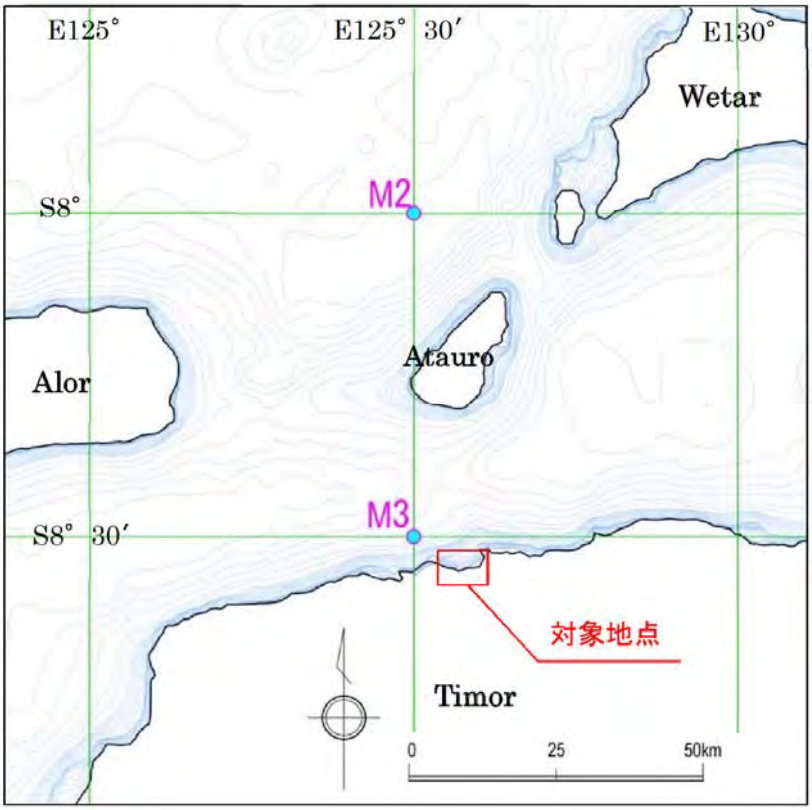
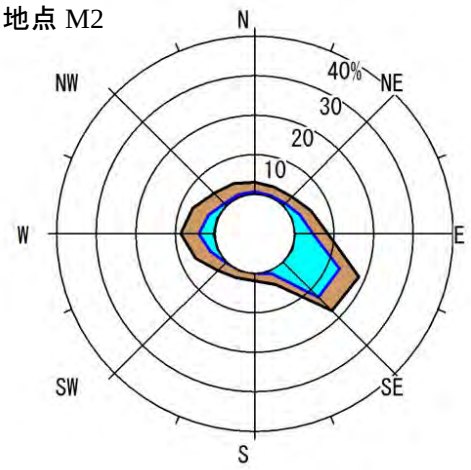


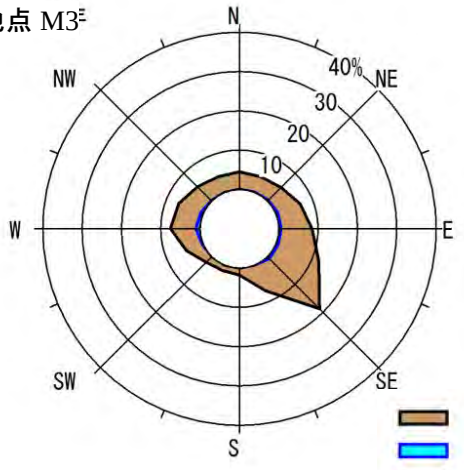
図 5-8　DILI 近郊推算地点（NOAA）

図 5-9 及び表 5-2 に各地点での再解析データ（NOAA）の風配図、頻度表を示す。地点 M3 ではティモール島の影響を受けるので地点 M2 に対し風速は弱くなるが、風向は年間を通じ、同様の傾向にある。

地点 M2



地点 M3



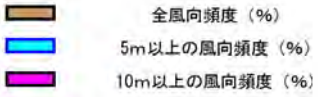


図 5-9　風配図（期間：1980 年 1 月～2014 年 12 月）

表 5-2　風頻度表（期間：1980 年 1 月～2014 年 12 月）

地点 M2

Observed	102272
Missing	0
Calm	74

Wind Direction Wind Speed(m/s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	Total	(0.1%)
-4.99	2386	2431	3073	3888	5431	4908	3114	1966	2129	2956	4294	4641	4442	3750	3089	2470	54968	(537)
5.00- 9.99	500	886	2387	4742	13198	12957	921	23	33	278	1967	3888	2469	804	713	625	46391	(453)
10.00- 14.99	.	.	1	42	221	56	1	.	.	.	53	310	131	15	5	.	835	(8)
15.00- 19.99	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	4	(0)
20.00-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	(0)
Total	2886	3317	5461	8672	18850	17921	4036	1989	2162	3234	6314	8841	7044	4569	3807	3095	102198	
(0.1%)	(28)	(32)	(53)	(84)	(184)	(175)	(39)	(19)	(21)	(31)	(61)	(86)	(68)	(44)	(37)	(30)	(999)	

地点 M3

Observed	102272
Missing	0
Calm	122

Wind Direction Wind Speed(m/s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	Total	(0.1%)
-4.99	4290	4664	6200	8051	11465	18387	7142	1818	1482	2093	4457	6633	6223	5059	4374	4518	96856	(947)
5.00- 9.99	96	334	609	604	618	817	40	1	.	9	229	1055	652	123	41	62	5290	(51)
10.00- 14.99	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	4	(0)
15.00- 19.99	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	(0)
20.00-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	(0)
Total	4386	4998	6809	8655	12083	19204	7182	1819	1482	2102	4687	7691	6875	5182	4415	4580	102150	
(0.1%)	(42)	(48)	(66)	(84)	(118)	(187)	(70)	(17)	(14)	(20)	(45)	(75)	(67)	(50)	(43)	(44)	(998)	

5-2-1-1-3　　波浪

波浪は、風の再解析データの M2、M3 地点における、NOAA による推算結果を利用した。図 5-10～図 5-11、表 5-3～表 5-8 に NOAA による推算結果の頻度図表を示す。同図表によれば地点 M2 はアロル島とティモール島の間からインド洋のうねりが来襲していることが分かる。また、ウェタル島の影響のためか、NNE～ENE の出現頻度がきわめて少なくなっている。

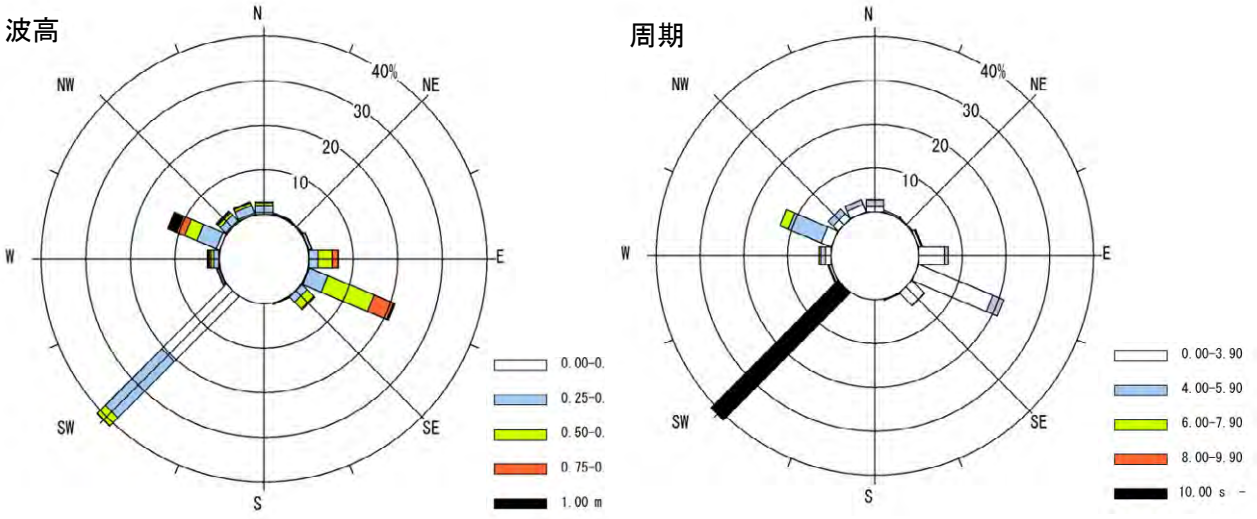


図 5-10　頻度分布図（地点 M2）

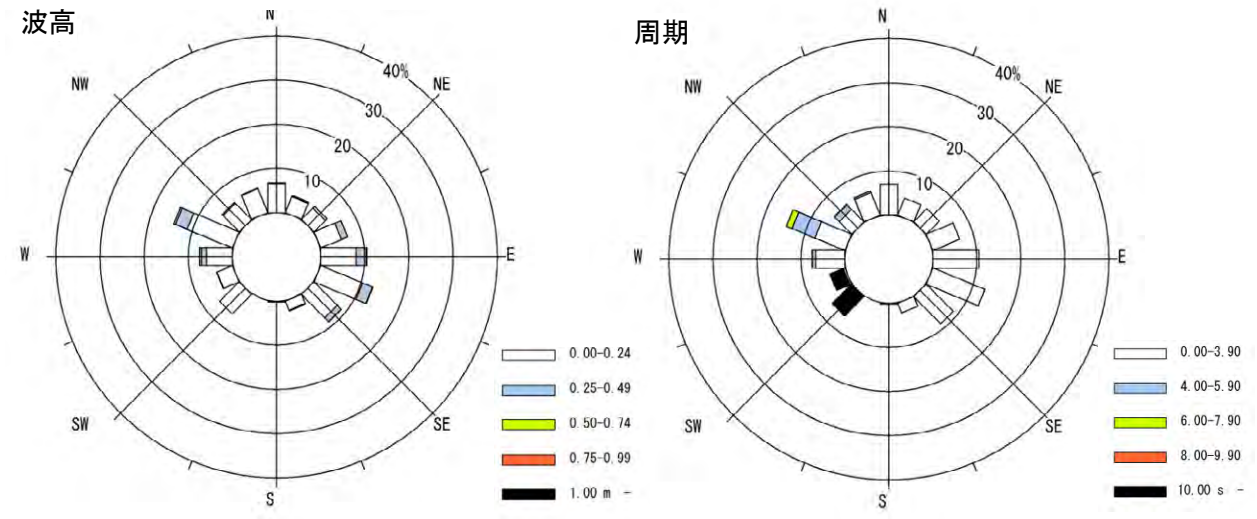


図 5-11　頻度分布図（地点 M3）

Table-(1) Wave Frequency Distribution by Periods

Month: 198001-201412
Point: DILI(35M2) All months
Wave Direction: All directions

Observed	102253	(99.98)
Calm		(0.00)
Missing	19	(0.02)

Wave Period(s) / Wave Height(m)	— 2.9	3.0 — 3.9	4.0 — 4.9	5.0 — 5.9	6.0 — 6.9	7.0 — 7.9	8.0 — 8.9	9.0 — 9.9	10.0 — 10.9	11.0 — 11.9	12.0 — 12.9	13.0 — 13.9	14.0 — 14.9	15.0 — 15.9	16.0 — 16.9	17.0 — 17.9	18.0 — 18.9	19.0 —	Total	Exceedance
— 0.24	1134 (1.11)	1558 (1.52)	518 (0.51)	44 (0.04)	18 (0.02)	1 (0.00)	17 (0.02)	35 (0.03)	490 (0.48)	2905 (2.84)	4617 (4.52)	4714 (4.61)	3452 (3.38)	2219 (2.17)	1286 (1.26)	744 (0.73)	183 (0.18)	247 (0.24)	24182 (23.65)	102253 (100.00)
0.25 — 0.49	8092 (7.91)	7250 (7.09)	5179 (5.06)	538 (0.53)	65 (0.06)	23 (0.02)	2 (0.00)	9 (0.01)	32 (0.03)	582 (0.57)	1984 (1.94)	3945 (3.86)	4586 (4.48)	3390 (3.32)	2029 (1.98)	1023 (1.00)	400 (0.39)	372 (0.36)	39501 (38.63)	78071 (76.35)
0.50 — 0.74	765 (0.75)	16965 (16.59)	2950 (2.89)	2025 (1.98)	99 (0.10)	20 (0.02)	10 (0.01)		1 (0.00)		5 (0.00)	89 (0.09)	442 (0.43)	802 (0.78)	645 (0.63)	321 (0.31)	125 (0.12)	86 (0.08)	25350 (24.79)	38570 (37.72)
0.75 — 0.99	4 (0.00)	3983 (3.90)	3357 (3.28)	1526 (1.49)	553 (0.54)	26 (0.03)	7 (0.01)				1 (0.00)			3 (0.00)	31 (0.03)	28 (0.03)	8 (0.01)	12 (0.01)	9539 (9.33)	13220 (12.93)
1.00 — 1.24		8 (0.01)	763 (0.75)	588 (0.58)	624 (0.61)	48 (0.05)	4 (0.00)												2035 (1.99)	3681 (3.60)
1.25 — 1.49			54 (0.05)	284 (0.28)	409 (0.40)	65 (0.06)	9 (0.01)												821 (0.80)	1646 (1.61)
1.50 — 1.74			1 (0.00)	75 (0.07)	201 (0.20)	134 (0.13)	8 (0.01)												419 (0.41)	825 (0.81)
1.75 — 1.99				5 (0.00)	87 (0.09)	121 (0.12)	1 (0.00)												214 (0.21)	406 (0.40)
2.00 — 2.24					33 (0.03)	88 (0.09)	6 (0.01)												127 (0.12)	192 (0.19)
2.25 — 2.49					7 (0.01)	30 (0.03)	8 (0.01)												45 (0.04)	65 (0.06)
2.50 — 2.74						13 (0.01)	1 (0.00)												14 (0.01)	20 (0.02)
2.75 — 2.99						1 (0.00)	3 (0.00)												4 (0.00)	6 (0.01)
3.00 — 3.24							2 (0.00)												2 (0.00)	2 (0.00)
3.25 — 3.49																			0 (0.00)	0 (0.00)
3.50 — 3.74																			0 (0.00)	0 (0.00)
3.75 — 3.99																			0 (0.00)	0 (0.00)
4.00 — 4.24																			0 (0.00)	0 (0.00)
4.25 — 4.49																			0 (0.00)	0 (0.00)
4.50 — 4.74																			0 (0.00)	0 (0.00)
4.75 — 4.99																			0 (0.00)	0 (0.00)
5.00 — 5.24																			0 (0.00)	0 (0.00)
5.25 — 5.49																			0 (0.00)	0 (0.00)
5.50 — 5.74																			0 (0.00)	0 (0.00)
5.75 — 5.99																			0 (0.00)	0 (0.00)
6.00 —																			0 (0.00)	0 (0.00)
Total	9995 (9.77)	29764 (29.11)	12822 (12.54)	5085 (4.97)	2096 (2.05)	570 (0.56)	78 (0.08)	44 (0.04)	523 (0.51)	3487 (3.41)	6607 (6.46)	8748 (8.56)	8480 (8.29)	6414 (6.27)	3991 (3.90)	2116 (2.07)	716 (0.70)	717 (0.70)	102253 (100.00)	
Exceedance	102253 (100.00)	92258 (90.23)	62494 (61.12)	49672 (48.58)	44587 (43.60)	42491 (41.55)	41921 (41.00)	41843 (40.92)	41799 (40.88)	41276 (40.37)	37789 (36.96)	31182 (30.49)	22434 (21.94)	13954 (13.65)	7540 (7.37)	3549 (3.47)	1433 (1.40)	717 (0.70)		

表 5-3 地点 M2 波高・周期頻度表

表 5-4　地点 M2　波高・波向頻度表

Month: 198001-201412
Point: DLR(3342) All months

Observed	102253	(99.98)
Calm	0	(0.00)
Missing	19	(0.02)

Wave Direction / Wave Height(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 0.24	100 (0.10)	57 (0.06)	149 (0.15)	94 (0.09)	199 (0.19)	118 (0.12)	38 (0.06)	27 (0.03)	25 (0.02)	20862 (20.40)	297 (0.20)	254 (0.25)	838 (0.82)	352 (0.34)	445 (0.44)	397 (0.39)	0 (0.00)	24182 (23.65)	102253 (100.00)
0.25 - 0.49	304 (0.30)	216 (0.21)	610 (0.60)	2021 (1.98)	4625 (4.52)	1593 (1.56)	153 (0.15)	20 (0.02)	23 (0.02)	18383 (17.98)	423 (0.41)	1080 (1.06)	4776 (4.67)	1738 (1.70)	1880 (1.84)	1656 (1.62)		39501 (38.63)	78071 (76.35)
0.50 - 0.74	8 (0.01)	8 (0.01)	152 (0.15)	3264 (3.19)	11472 (11.22)	2134 (2.09)	15 (0.01)	1 (0.00)	2 (0.00)	2518 (2.46)	134 (0.13)	652 (0.64)	3098 (3.03)	724 (0.71)	568 (0.56)	600 (0.59)		25350 (24.79)	38570 (37.72)
0.75 - 0.99	2 (0.00)		6 (0.01)	1376 (1.35)	4802 (4.70)	266 (0.26)				84 (0.08)	49 (0.05)	377 (0.37)	1946 (1.90)	283 (0.28)	199 (0.19)	149 (0.15)		9539 (9.33)	13220 (12.93)
1.00 - 1.24			1 (0.00)	146 (0.14)	422 (0.41)	7 (0.01)				12 (0.01)		218 (0.21)	1012 (0.99)	113 (0.11)	51 (0.05)	53 (0.05)		2035 (1.99)	3681 (3.60)
1.25 - 1.49				7 (0.01)	28 (0.03)	1 (0.00)				10 (0.01)		127 (0.12)	551 (0.54)	42 (0.04)	32 (0.03)	23 (0.02)		821 (0.80)	1646 (1.61)
1.50 - 1.74										1 (0.00)		71 (0.07)	318 (0.31)	6 (0.01)	14 (0.01)	9 (0.01)		419 (0.41)	825 (0.81)
1.75 - 1.99												20 (0.02)	194 (0.19)					214 (0.21)	406 (0.40)
2.00 - 2.24												13 (0.01)	114 (0.11)					127 (0.12)	192 (0.19)
2.25 - 2.49													45 (0.04)					48 (0.04)	65 (0.06)
2.50 - 2.74													14 (0.01)					14 (0.01)	20 (0.02)
2.75 - 2.99													4 (0.00)					4 (0.00)	6 (0.01)
3.00 - 3.24													2 (0.00)					2 (0.00)	2 (0.00)
3.25 - 3.49																		0 (0.00)	0 (0.00)
3.50 - 3.74																		0 (0.00)	0 (0.00)
3.75 - 3.99																		0 (0.00)	0 (0.00)
4.00 - 4.24																		0 (0.00)	0 (0.00)
4.25 - 4.49																		0 (0.00)	0 (0.00)
4.50 - 4.74																		0 (0.00)	0 (0.00)
4.75 - 4.99																		0 (0.00)	0 (0.00)
5.00 - 5.24																		0 (0.00)	0 (0.00)
5.25 - 5.49																		0 (0.00)	0 (0.00)
5.50 - 5.74																		0 (0.00)	0 (0.00)
5.75 - 5.99																		0 (0.00)	0 (0.00)
6.00 -																		0 (0.00)	0 (0.00)
Total	414 (0.40)	281 (0.27)	918 (0.90)	6908 (6.76)	21548 (21.07)	4119 (4.03)	226 (0.22)	48 (0.05)	50 (0.05)	41847 (40.92)	836 (0.82)	2812 (2.75)	12912 (12.63)	3258 (3.19)	3189 (3.12)	2887 (2.82)	0 (0.00)	102253 (100.00)	

表 5-5　地点 M2　周期・波向頻度表

Month: 198001-201412
Point: DIL(M2) All months

Observed	102253	(99.98)
Calm	0	(0.00)
Missing	19	(0.02)

Wave Direction / Wave Period(s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 2.99	282 (0.28)	209 (0.20)	484 (0.47)	1391 (1.36)	2729 (2.67)	1097 (1.07)	191 (0.19)	48 (0.05)	47 (0.05)	89 (0.09)	253 (0.25)	423 (0.41)	397 (0.39)	519 (0.51)	1081 (1.06)	755 (0.74)	0 (0.00)	9995 (9.77)	102253 (100.00)
3.00 - 3.99	84 (0.08)	44 (0.04)	159 (0.16)	4643 (4.54)	16109 (15.75)	2962 (2.90)	35 (0.03)		3 (0.00)	15 (0.01)	267 (0.26)	879 (0.86)	2130 (2.08)	1150 (1.12)	798 (0.78)	486 (0.48)		29764 (29.11)	92258 (90.23)
4.00 - 4.99	46 (0.04)	21 (0.02)	104 (0.10)	866 (0.85)	2702 (2.64)	60 (0.06)					189 (0.18)	662 (0.65)	4978 (4.87)	1228 (1.20)	955 (0.93)	1011 (0.99)		12822 (12.54)	62494 (61.12)
5.00 - 5.99	1 (0.00)	4 (0.00)	81 (0.08)	7 (0.01)	8 (0.01)						9 (0.01)	419 (0.41)	3370 (3.30)	335 (0.33)	309 (0.30)	542 (0.53)		5085 (4.97)	49672 (48.58)
6.00 - 6.99	1 (0.00)	3 (0.00)	71 (0.07)	1 (0.00)								264 (0.26)	1599 (1.56)	26 (0.03)	42 (0.04)	89 (0.09)		2096 (2.05)	44587 (43.60)
7.00 - 7.99			17 (0.02)									126 (0.12)	419 (0.41)		4 (0.00)	4 (0.00)		570 (0.56)	42491 (41.55)
8.00 - 8.99			2 (0.00)							12 (0.01)	7 (0.01)	38 (0.04)	19 (0.02)					78 (0.08)	41921 (41.00)
9.00 - 9.99										41 (0.04)	3 (0.00)							44 (0.04)	41843 (40.92)
10.00 - 10.99										507 (0.50)	16 (0.02)							523 (0.51)	41799 (40.88)
11.00 - 11.99										3464 (3.39)	22 (0.02)	1 (0.00)						3487 (3.41)	41276 (40.37)
12.00 - 12.99										6592 (6.45)	15 (0.01)							6607 (6.46)	37789 (36.96)
13.00 - 13.99										8738 (8.55)	10 (0.01)							8748 (8.56)	31182 (30.49)
14.00 - 14.99										8462 (8.28)	18 (0.02)							8480 (8.29)	22434 (21.94)
15.00 - 15.99										6405 (6.26)	9 (0.01)							6414 (6.27)	13954 (13.65)
16.00 - 16.99										3984 (3.90)	7 (0.01)							3991 (3.90)	7540 (7.37)
17.00 - 17.99										2108 (2.06)	8 (0.01)							2116 (2.07)	3549 (3.47)
18.00 - 18.99										715 (0.70)	1 (0.00)							716 (0.70)	1433 (1.40)
19.00 -										715 (0.70)	2 (0.00)							717 (0.70)	717 (0.70)
-																			
-																			
-																			
-																			
-																			
-																			
-																			
Total	414 (0.40)	281 (0.27)	918 (0.90)	6908 (6.76)	21548 (21.07)	4119 (4.03)	226 (0.22)	48 (0.05)	50 (0.05)	41847 (40.92)	836 (0.82)	2812 (2.75)	12912 (12.63)	3258 (3.19)	3189 (3.12)	2887 (2.82)	0 (0.00)	102253 (100.00)	
Exceedance	102253 (100.00)	101839 (99.60)	101558 (99.32)	100640 (98.42)	93732 (91.67)	72184 (70.59)	68065 (66.57)	67839 (66.34)	67791 (66.30)	67741 (66.25)	25894 (25.32)	25058 (24.51)	22246 (21.76)	9334 (9.13)	6076 (5.94)	2887 (2.82)	0 (0.00)		

表 5-6　地点 M3　波高・周期頻度表

Month: 198001-201412
Point: DIL(35M3) All months
Wave Direction: All directions

Observed	100342 (98.11)
Calm	(0.00)
Missing	1939 (1.89)

Wave Period(s) / Wave Height(m)	– 2.9	3.0 – 3.9	4.0 – 4.9	5.0 – 5.9	6.0 – 6.9	7.0 – 7.9	8.0 – 8.9	9.0 – 9.9	10.0 – 10.9	11.0 – 11.9	12.0 – 12.9	13.0 – 13.9	14.0 – 14.9	15.0 – 15.9	16.0 – 16.9	17.0 – 17.9	18.0 – 18.9	19.0 –	Total	Exceedance
– 0.24	61706 (61.50)	5975 (5.95)	5393 (5.37)	2528 (2.52)	547 (0.55)	102 (0.10)	296 (0.29)	124 (0.12)	182 (0.18)	531 (0.53)	1063 (1.06)	1592 (1.59)	1796 (1.79)	1291 (1.29)	1102 (1.10)	776 (0.77)	237 (0.24)	427 (0.43)	85667 (85.38)	100342 (100.00)
0.25 – 0.49	11146 (11.11)	954 (0.95)	19 (0.02)	423 (0.42)	763 (0.76)	138 (0.14)	1 (0.00)					2 (0.00)							13444 (13.40)	14675 (14.62)
0.50 – 0.74	169 (0.17)	798 (0.80)	2 (0.00)		34 (0.03)	134 (0.13)	8 (0.01)												1145 (1.14)	1231 (1.23)
0.75 – 0.99	11 (0.01)	37 (0.04)	21 (0.02)			3 (0.00)	3 (0.00)												75 (0.07)	86 (0.09)
1.00 – 1.24			11 (0.01)																11 (0.01)	11 (0.01)
1.25 – 1.49																			0 (0.00)	0 (0.00)
1.50 – 1.74																			0 (0.00)	0 (0.00)
1.75 – 1.99																			0 (0.00)	0 (0.00)
2.00 – 2.24																			0 (0.00)	0 (0.00)
2.25 – 2.49																			0 (0.00)	0 (0.00)
2.50 – 2.74																			0 (0.00)	0 (0.00)
2.75 – 2.99																			0 (0.00)	0 (0.00)
3.00 – 3.24																			0 (0.00)	0 (0.00)
3.25 – 3.49																			0 (0.00)	0 (0.00)
3.50 – 3.74																			0 (0.00)	0 (0.00)
3.75 – 3.99																			0 (0.00)	0 (0.00)
4.00 – 4.24																			0 (0.00)	0 (0.00)
4.25 – 4.49																			0 (0.00)	0 (0.00)
4.50 – 4.74																			0 (0.00)	0 (0.00)
4.75 – 4.99																			0 (0.00)	0 (0.00)
5.00 – 5.24																			0 (0.00)	0 (0.00)
5.25 – 5.49																			0 (0.00)	0 (0.00)
5.50 – 5.74																			0 (0.00)	0 (0.00)
5.75 – 5.99																			0 (0.00)	0 (0.00)
6.00 –																			0 (0.00)	0 (0.00)
Total	73032 (72.78)	7764 (7.74)	5446 (5.43)	2951 (2.94)	1344 (1.34)	375 (0.37)	307 (0.31)	124 (0.12)	182 (0.18)	531 (0.53)	1063 (1.06)	1594 (1.59)	1796 (1.79)	1291 (1.29)	1102 (1.10)	776 (0.77)	237 (0.24)	427 (0.43)	100342 (100.00)	
Exceedance	100342 (100.00)	27310 (27.22)	19546 (19.48)	14100 (14.05)	11149 (11.11)	9805 (9.77)	9430 (9.40)	9123 (9.09)	8999 (8.97)	8817 (8.79)	8286 (8.26)	7223 (7.20)	5629 (5.61)	3838 (3.82)	2542 (2.53)	1440 (1.44)	664 (0.66)	427 (0.43)		

Month: 198001-201412
Point: DILI(35M3) All months

Observed	100342	(98.11)
Calm	0	(0.00)
Missing	1930	(1.89)

Wave Direction / Wave Height(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 0.24	3867 (3.85)	3599 (3.59)	5150 (5.13)	8048 (8.02)	10286 (10.25)	7478 (7.45)	2158 (2.15)	234 (0.23)	21 (0.02)	6187 (6.17)	3766 (3.75)	5901 (5.88)	11141 (11.10)	5260 (5.24)	5911 (5.89)	6660 (6.64)	0 (0.00)	85667 (85.38)	100342 (100.00)
0.25 - 0.49	326 (0.32)	592 (0.59)	1456 (1.45)	2407 (2.40)	2441 (2.43)	1186 (1.18)	195 (0.19)	5 (0.00)	1 (0.00)	4 (0.00)	64 (0.06)	1224 (1.22)	2885 (2.88)	316 (0.31)	92 (0.09)	250 (0.25)		13444 (13.40)	14675 (14.62)
0.50 - 0.74		2 (0.00)	32 (0.03)	62 (0.06)	131 (0.13)	65 (0.06)	12 (0.01)				15 (0.01)	384 (0.38)	426 (0.42)	14 (0.01)	1 (0.00)	1 (0.00)		1145 (1.14)	1231 (1.23)
0.75 - 0.99			1 (0.00)	4 (0.00)	7 (0.01)	2 (0.00)	1 (0.00)					27 (0.03)	33 (0.03)					75 (0.07)	86 (0.09)
1.00 - 1.24												11 (0.01)						11 (0.01)	11 (0.01)
1.25 - 1.49																		0 (0.00)	0 (0.00)
1.50 - 1.74																		0 (0.00)	0 (0.00)
1.75 - 1.99																		0 (0.00)	0 (0.00)
2.00 - 2.24																		0 (0.00)	0 (0.00)
2.25 - 2.49																		0 (0.00)	0 (0.00)
2.50 - 2.74																		0 (0.00)	0 (0.00)
2.75 - 2.99																		0 (0.00)	0 (0.00)
3.00 - 3.24																		0 (0.00)	0 (0.00)
3.25 - 3.49																		0 (0.00)	0 (0.00)
3.50 - 3.74																		0 (0.00)	0 (0.00)
3.75 - 3.99																		0 (0.00)	0 (0.00)
4.00 - 4.24																		0 (0.00)	0 (0.00)
4.25 - 4.49																		0 (0.00)	0 (0.00)
4.50 - 4.74																		0 (0.00)	0 (0.00)
4.75 - 4.99																		0 (0.00)	0 (0.00)
5.00 - 5.24																		0 (0.00)	0 (0.00)
5.25 - 5.49																		0 (0.00)	0 (0.00)
5.50 - 5.74																		0 (0.00)	0 (0.00)
5.75 - 5.99																		0 (0.00)	0 (0.00)
6.00 -																		0 (0.00)	0 (0.00)
Total	4193 (4.18)	4193 (4.18)	6639 (6.62)	10521 (10.49)	12865 (12.82)	8731 (8.70)	2366 (2.36)	239 (0.24)	22 (0.02)	6191 (6.17)	3845 (3.83)	7547 (7.52)	14485 (14.44)	5590 (5.57)	6004 (5.98)	6911 (6.89)	0 (0.00)	100342 (100.00)	

表 5-7　地点 M3　波高・波向頻度表

表 5-8　地点 M3　周期・波向頻度表

Month : 198001-201412
Point : DIL0(M3) All months

Observed	100342	(98.11)
Calm	0	(0.00)
Missing	1930	(1.89)

Wave Direction / Wave Period(s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 2.99	4193 (4.18)	4177 (4.16)	6491 (6.47)	10206 (10.17)	12526 (12.48)	8531 (8.50)	2312 (2.30)	205 (0.20)	21 (0.02)	33 (0.03)	246 (0.25)	3620 (3.61)	5218 (5.20)	3130 (3.12)	5238 (5.22)	6885 (6.86)	0 (0.00)	73032 (72.78)	100342 (100.00)
3.00 - 3.99		16 (0.02)	148 (0.15)	315 (0.31)	339 (0.34)	200 (0.20)	54 (0.05)	34 (0.03)	1 (0.00)	4 (0.00)	202 (0.20)	3016 (3.01)	2247 (2.24)	864 (0.86)	320 (0.32)	4 (0.00)		7764 (7.74)	27310 (27.22)
4.00 - 4.99										93 (0.09)	658 (0.66)	3310 (3.30)	1063 (1.06)	302 (0.30)	20 (0.02)		5446 (5.43)	19546 (19.48)
5.00 - 5.99										8 (0.01)	133 (0.13)	2273 (2.27)	427 (0.43)	108 (0.11)	2 (0.00)		2951 (2.94)	14100 (14.05)
6.00 - 6.99										5 (0.00)	64 (0.06)	1151 (1.15)	92 (0.09)	32 (0.03)			1344 (1.34)	11149 (11.11)
7.00 - 7.99									1 (0.00)	44 (0.04)	40 (0.04)	273 (0.27)	13 (0.01)	4 (0.00)			375 (0.37)	9805 (9.77)
8.00 - 8.99									139 (0.14)	143 (0.14)	11 (0.01)	13 (0.01)	1 (0.00)				307 (0.31)	9430 (9.40)
9.00 - 9.99									21 (0.02)	99 (0.10)	4 (0.00)						124 (0.12)	9123 (9.09)
10.00 - 10.99									79 (0.08)	103 (0.10)							182 (0.18)	8999 (8.97)
11.00 - 11.99									374 (0.37)	157 (0.16)							531 (0.53)	8817 (8.79)
12.00 - 12.99									806 (0.80)	256 (0.26)	1 (0.00)						1063 (1.06)	8286 (8.26)
13.00 - 13.99									1175 (1.17)	419 (0.42)							1594 (1.59)	7223 (7.20)
14.00 - 14.99									1241 (1.24)	555 (0.55)							1796 (1.79)	5629 (5.61)
15.00 - 15.99									874 (0.87)	417 (0.42)							1291 (1.29)	3833 (3.82)
16.00 - 16.99									660 (0.66)	442 (0.44)							1102 (1.10)	2542 (2.53)
17.00 - 17.99									442 (0.44)	334 (0.33)							776 (0.77)	1440 (1.44)
18.00 - 18.99									118 (0.12)	119 (0.12)							237 (0.24)	664 (0.66)
19.00 -									224 (0.22)	203 (0.20)							427 (0.43)	427 (0.43)
-																			
-																			
-																			
-																			
-																			
-																			
-																			
Total	4193 (4.18)	4193 (4.18)	6639 (6.62)	10521 (10.49)	12865 (12.82)	8731 (8.70)	2366 (2.36)	239 (0.24)	22 (0.02)	6191 (6.17)	3845 (3.83)	7547 (7.52)	14485 (14.44)	5590 (5.57)	6004 (5.98)	6911 (6.89)	0 (0.00)	100342 (100.00)	
Exceedance	100342 (100.00)	96149 (95.82)	91956 (91.64)	85317 (85.03)	74796 (74.54)	61931 (61.72)	53200 (53.02)	50834 (50.66)	50595 (50.42)	50573 (50.40)	44382 (44.23)	40537 (40.40)	32990 (32.88)	18505 (18.44)	12915 (12.87)	6911 (6.89)	0 (0.00)		

5-2-1-1-4　　潮位

ディリ港の潮位は、現地再委託調査結果より、表 5-9 の値とする。

表 5-9　潮位表

名　　称	潮　位
大潮平均高潮面　High Water Spring (HWS)	+ 2.8 m
平均高高潮位面　Mean Higher High Water (MHHW)	+ 2.3 m
平均低高潮位面　Mean Lower High Water (MLHW)	+1.8 m
平均水面　Mean Sea Level (MSL)	+ 1.4 m
平均高低潮位面　Mean Higher Low Water (MHLW)	+1.0 m
平均低低潮位面　Mean Lower Low Water (MLLW)	+0.4 m
大潮平均低潮面　Low Water Spring	±0.0 m
最低水面　　Chart Datum (CD)	±0.0 m

出典 : Kepanduan Bahari Indonesia Wilayah III (Bahari Indonesia Scout Region III, Page 183),Indonesian Navy 2013

5-2-1-2　　確率波の検討

5-2-1-2-1　　波の確率波

(1)　年最大値の算出

波浪資料より、各地点における波向別年最大波を算出し、表 5-10 及び表 5-11 に整理した。表 5-10 は、地点 M2 における波向別年最大波である。NNE～ENE 方向では、抽出下限値を 0.75m としたとき、最大値の抽出が少ないため抽出下限値を 0.3m とした場合の波向別年最大波も算出した。表 5-11 は地点 M3 における波向別年最大波である。抽出下限値は全方向で 0.3m としている。

表 5-10　波向別年最大波（地点 M2）

		設計波対象方向															設計波対象方向			
抽出条件		0.3m 以上			0.75m 以上															
波向		22.5	45	67.5	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247.5	270	292.5	315	337.5	360
取得年月		NNE	NE	ENE	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
198010	H	0.3	0.36	0.12	-	-	-	1.21	132	-	-	-	-	0.88	-	1.74	2.3	1.11	0.85	0.77
198010	T	1.95	2.4	3.39	-	-	-	5.01	494	-	-	-	-	17.77	-	5.97	7.25	5.63	5.41	5.05
198112	H	0.46	0.38	0.66	-	-	-	1	114	-	-	-	-	0.85	0.88	1.72	2.39	1.67	1.18	1.03
198112	T	2.67	2.71	7.16	-	-	-	4.63	435	-	-	-	-	17.45	4.03	6.21	8.07	5.91	6.4	6.07
198210	H	0.6	0.43	0.69	-	-	-	1.14	107	0.89	-	-	-	0.76	-	1.08	1.92	1.33	-	-
198210	T	3.08	2.77	3.52	-	-	-	4.47	432	3.82	-	-	-	21.48	-	6.87	6.38	5.64	-	-
198311	H	0.58	0.42	0.52	-	-	-	1.42	125	0.96	-	-	-	0.78	-	-	0.87	0.83	1.54	1.6
198311	T	5.82	2.72	2.19	-	-	-	4.91	454	4.15	-	-	-	17.93	-	-	3.76	4.01	5.73	7.12
198412	H	0.48	0.5	0.68	-	-	-	1.16	121	1.01	-	-	-	-	-	1.45	1.48	1.28	0.83	-
198412	T	2.81	2.99	3.32	-	-	-	4.48	461	4.43	-	-	-	-	-	5.73	5.58	5.19	5.23	-
198510	H	-	0.39	0.54	-	-	-	1.21	123	0.87	-	-	-	0.9	-	1.36	2.44	1.13	0.93	-
198510	T	-	2.56	2.62	-	-	-	4.8	471	3.73	-	-	-	16.99	-	7.76	6.97	4.63	3.85	-
198611	H	0.35	0.33	0.7	-	-	-	1.22	114	0.81	-	-	-	-	-	1.71	2.5	0.8	-	-
198611	T	2.35	2.5	3.32	-	-	-	4.77	437	3.78	-	-	-	-	-	7.91	7.35	4.96	-	-
198712	H	0.43	0.54	0.85	-	-	0.85	1.16	111	0.76	-	-	-	-	0.77	1.43	2.29	1.65	0.98	1.04
198712	T	2.52	5.21	3.66	-	-	3.66	4.6	439	3.94	-	-	-	-	3.95	5.71	6.93	6.45	5.68	6.35
198812	H	0.39	-	0.67	-	-	-	1.05	1.1	0.86	-	-	-	0.79	0.99	1.54	1.58	0.85	0.95	-
198812	T	2.5	-	3.35	-	-	-	4.11	442	3.84	-	-	-	18.14	4.3	5.55	6.56	5.86	5.13	-
198911	H	-	0.36	0.48	-	-	-	0.94	099	0.83	-	-	-	-	1.34	1.28	2.26	0.91	-	-
198911	T	-	2.42	2.85	-	-	-	4.22	396	3.82	-	-	-	-	5.07	5.2	7.33	6.29	-	-
199012	H	0.44	0.52	0.63	-	-	-	1.03	101	-	-	-	-	0.82	1.12	1.56	1.36	0.99	0.85	1.05
199012	T	2.54	2.83	3.19	-	-	-	4.28	426	-	-	-	-	18.7	4.41	5.69	6.36	5.79	5.66	6.33
199112	H	0.42	0.34	0.54	-	-	-	1.06	098	-	-	-	-	-	-	1.33	1.69	1.48	1.32	1.19
199112	T	2.5	2.23	3.1	-	-	-	4.31	441	-	-	-	-	-	-	6.43	6.68	6.17	5.87	6.02
199212	H	0.45	0.43	0.62	-	-	-	1.03	104	0.82	-	-	-	0.92	-	1.05	1.49	1.22	0.96	1.06
199212	T	2.69	2.91	3.13	-	-	-	4.36	437	4.1	-	-	-	18.55	-	4.36	5.46	5.02	4.5	5.56
199312	H	0.93	0.33	1.06	0.93	-	1.06	1.2	149	1.3	-	-	-	0.86	1.1	2.14	2.88	1.47	1.34	0.9
199312	T	4.99	2.35	4.23	4.99	-	4.23	4.6	506	4.36	-	-	-	19.36	4.57	6.98	8.34	6.05	5.94	5.85
199409	H	0.4	0.44	0.58	-	-	-	1.1	1.2	0.82	-	-	-	-	-	-	1.22	1.71	1.61	0.94
199409	T	2.49	2.84	3.26	-	-	-	4.59	451	3.73	-	-	-	-	-	-	5.03	5.67	5.98	5.58
199512	H	0.43	0.48	0.51	-	-	-	1.13	107	0.77	-	-	-	-	-	1.21	1.84	1.39	1.24	1.23
199512	T	2.49	2.86	3.03	-	-	-	4.59	432	3.79	-	-	-	-	-	4.74	7.15	6.06	5.58	5.97
199612	H	0.52	0.45	0.52	-	-	-	0.97	105	0.76	-	-	-	0.79	-	0.79	2.06	1.15	-	-
199612	T	2.78	2.55	2.89	-	-	-	4.17	435	3.86	-	-	-	15.29	-	4.01	7.5	6.48	-	-
199712	H	0.46	0.5	0.63	-	-	-	1.13	122	0.88	-	-	-	-	1.15	1.19	2.16	1.07	0.87	-
199712	T	2.67	2.88	3.1	-	-	-	4.5	454	4.01	-	-	-	-	4.49	5.08	7.22	5.91	4.82	-
199812	H	0.43	0.47	0.58	-	-	-	1.04	107	0.79	-	-	-	0.8	1.18	1.16	1.07	1.16	1.72	0.87
199812	T	4.88	6.7	6.03	-	-	-	4.25	426	3.97	-	-	-	16.69	4.83	4.85	4.18	4.63	5.86	5.09
199910	H	-	-	0.54	-	-	-	1	109	1.02	-	-	-	0.75	-	1.26	1.28	-	-	-
199910	T	-	-	2.87	-	-	-	4.02	436	4.29	-	-	-	16.21	-	5.01	6.24	-	-	-
200012	H	0.3	0.33	0.19	-	-	0.79	1.34	134	1.03	-	-	-	-	0.79	1.5	1.57	1.3	1.04	0.87
200012	T	4.04	2.19	3.76	-	-	3.76	4.87	502	4.14	-	-	-	-	3.46	5.19	6.08	5.92	5.37	5.51
200112	H	0.34	0.37	0.55	-	-	-	1.07	121	0.98	-	-	-	0.81	0.81	1.65	1.66	0.81	-	-
200112	T	2.55	2.56	5.44	-	-	-	4.25	455	4.05	-	-	-	17.64	3.75	8.8	6.81	5.19	-	-
200212	H	0.44	0.42	0.59	-	-	-	1.08	104	0.84	-	-	-	-	-	1.32	1.35	1.05	1.46	1.66
200212	T	2.57	2.73	3.09	-	-	-	4.5	4.4	3.83	-	-	-	-	-	5.1	5.22	5.16	6.41	6.5
200312	H	0.53	0.6	0.75	-	-	0.75	1.11	106	0.79	-	-	-	-	1.5	2.14	2.15	1.04	1.02	0.92
200312	T	3.39	3.19	7.86	-	-	7.86	4.51	417	3.84	-	-	-	-	5.4	6.21	7.69	5.77	5.65	5.47
200412	H	0.43	0.46	0.57	-	-	-	0.95	131	0.89	-	-	-	-	0.75	1.98	3.07	0.81	0.76	-
200412	T	2.49	2.84	3.14	-	-	-	4.21	482	3.95	-	-	-	-	3.83	6.6	8.28	5.61	5.61	-
200509	H	0.42	0.35	0.55	-	-	-	1.1	099	0.78	-	-	-	0.76	-	1.31	1.72	0.96	-	-
200509	T	2.41	2.43	2.96	-	-	-	4.48	401	3.75	-	-	-	15.94	-	4.99	5.91	4.67	-	-
200611	H	0.49	0.44	0.82	-	-	0.82	1.22	115	0.82	-	-	-	-	-	1.26	2.65	1.2	-	-
200611	T	2.71	2.56	3.47	-	-	3.47	4.31	435	3.8	-	-	-	-	-	6.24	7.72	6.24	-	-
200712	H	0.41	0.38	0.7	-	-	-	1.27	125	0.89	-	-	-	0.81	-	1.58	1.68	1.34	1	-
200712	T	2.52	2.36	3.08	-	-	-	4.89	475	3.95	-	-	-	17.95	-	5.4	5.37	5.22	5.74	-
200812	H	0.49	0.46	0.78	-	-	0.78	1.14	128	1	-	-	-	-	-	1.88	2.33	0.78	-	-
200812	T	2.69	2.92	3.56	-	-	3.56	4.56	463	4.06	-	-	-	-	-	6.05	6.89	4.62	-	-
200912	H	0.4	0.39	0.59	-	-	-	1.16	106	0.77	-	-	-	-	-	1.23	1.45	0.97	-	-
200912	T	2.46	2.7	3.08	-	-	-	4.3	421	3.74	-	-	-	-	-	7.1	6.76	5.32	-	-
201012	H	-	-	0.69	-	-	-	1.18	147	0.94	-	-	-	-	0.88	0.85	1.41	0.95	0.93	0.86
201012	T	-	-	8.32	-	-	-	4.64	505	3.93	-	-	-	-	3.94	4.01	6.09	4.65	5.05	5.07
201109	H	-	-	0.66	-	-	-	-	105	0.9	-	-	-	0.81	0.82	1.98	2.34	0.75	-	-
201109	T	-	-	777	-	-	-	-	419	4.01	-	-	-	2.57	4	6.27	7.5	4.44	-	-
201208	H	-	-	0.37	-	-	-	-	109	1.04	-	-	-	0.95	-	1.06	1.6	1.19	1.61	1.59
201208	T	-	-	777	-	-	-	-	428	4.24	-	-	-	12.43	-	4.73	6.38	5.2	6.35	6.65
201312	H	-	-	0.64	-	-	-	0.86	132	0.85	-	-	-	-	-	1.47	2.31	1.39	-	-
201312	T	-	-	777	-	-	-	3.81	469	3.84	-	-	-	-	-	6.7	7.41	5.12	-	-
201412	H	-	-	0.49	-	-	-	-	124	0.93	-	-	-	0.8	1.48	2.19	2.42	1.24	-	-
201412	T	-	-	7.21	-	-	-	-	48	4.03	-	-	-	16.37	5.45	6.96	7.41	5.78	-	-

H：波高(m)　T：周期(s)

表 5-11　波向別年最大波（地点 M3）

		設計波対象方向												設計波対象方向			
抽出条件		0.3m 以上															
波向		22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247.5	270	292.5	315	337.5	360
取得年月		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
198011	H	–	0.4	0.55	0.51	0.47	0.36	–	–	–	–	–	0.69	0.72	0.45	–	0.31
198011	T	–	2.52	2.97	2.96	2.88	2.57	–	–	–	–	–	3.51	7.34	6.45	–	2.48
198112	H	–	0.39	0.42	0.39	0.36	–	–	–	–	–	–	0.71	0.68	0.47	–	–
198112	T	–	2.59	2.7	2.66	2.58	–	–	–	–	–	–	3.39	3.3	8.27	–	–
198211	H	0.31	0.42	0.53	0.45	0.36	0.3	–	–	–	–	–	0.4	0.61	0.56	0.31	0.3
198211	T	2.16	2.71	3.09	2.87	2.47	2.37	–	–	–	–	–	2.76	3.24	6.66	2.41	2.29
198311	H	0.32	0.33	0.43	0.46	0.43	0.35	–	–	–	–	–	–	0.36	0.36	0.35	0.31
198311	T	2.25	2.54	2.79	2.88	2.73	2.53	–	–	–	–	–	–	2.52	2.53	2.49	2.52
198412	H	–	0.47	0.51	0.47	0.43	0.32	0.3	–	–	–	0.32	0.45	0.5	0.43	–	0.31
198412	T	–	2.89	2.89	2.84	2.69	2.52	2.33	–	–	–	2.57	2.83	2.99	2.8	–	2.38
198510	H	–	0.3	0.37	0.47	0.36	–	–	–	–	–	–	–	0.68	0.31	0.32	0.32
198510	T	–	2.2	2.49	2.82	2.38	–	–	–	–	–	–	–	3.31	5.95	2.54	2.34
198612	H	–	0.34	0.45	0.46	0.38	–	–	–	–	–	0.33	1	0.97	–	–	0.3
198612	T	–	2.34	2.73	2.9	2.76	–	–	–	–	–	2.36	4.25	4.22	–	–	2.13
198712	H	0.3	0.41	0.55	0.5	0.36	0.3	–	–	–	–	–	0.78	0.74	0.47	–	0.34
198712	T	2.17	2.5	3.11	2.85	2.48	2.36	–	–	–	–	–	3.74	3.67	2.86	–	2.5
198812	H	0.33	0.42	0.43	0.51	0.35	0.3	–	–	–	–	0.32	0.65	0.49	0.34	–	–
198812	T	2.5	2.81	2.55	3.01	2.52	2.2	–	–	–	–	2.3	3.51	2.93	2.52	–	–
198912	H	–	0.36	0.54	0.4	0.3	–	–	–	–	–	0.48	0.49	0.68	–	–	0.32
198912	T	–	2.32	2.95	2.69	2.4	–	–	–	–	–	2.88	3.06	3.4	–	–	2.44
199012	H	0.36	0.47	0.57	0.47	0.34	0.3	–	–	–	–	0.37	0.72	0.42	0.3	0.36	–
199012	T	2.35	2.76	3.16	2.93	2.39	2.33	–	–	–	–	2.76	3.58	2.8	2.21	2.54	–
199112	H	0.37	0.49	0.57	0.37	0.34	–	–	–	–	–	–	0.37	0.53	0.31	–	0.3
199112	T	2.42	2.76	3.24	2.57	2.51	–	–	–	–	–	–	2.85	3.11	2.28	–	2.19
199212	H	0.33	0.51	0.6	0.41	0.34	–	–	–	–	–	–	0.45	0.57	0.47	–	–
199212	T	2.31	3.03	3.12	2.56	2.46	–	–	–	–	–	–	2.75	3.11	2.8	–	–
199312	H	0.32	0.54	0.67	0.61	0.44	–	–	–	–	–	–	0.87	0.8	0.41	–	–
199312	T	2.65	3.05	3.46	3.38	2.85	–	–	–	–	–	–	3.74	8.36	6.03	–	–
199411	H	0.36	0.4	0.4	0.49	0.45	0.31	–	–	–	–	–	0.37	0.57	0.65	0.3	–
199411	T	2.38	2.75	2.46	3.04	2.68	2.41	–	–	–	–	–	2.55	3.25	3.4	2.41	–
199512	H	0.31	0.47	0.5	0.44	0.38	0.33	–	–	–	–	–	0.66	0.57	0.3	–	–
199512	T	2.43	2.97	3.07	2.78	2.65	2.39	–	–	–	–	–	3.46	3.06	2.23	–	–
199612	H	0.3	0.35	0.37	0.39	0.35	–	–	–	–	–	–	0.59	0.59	0.61	–	–
199612	T	2.18	2.36	2.52	2.59	2.57	–	–	–	–	–	–	3.28	3.28	7.42	–	–
199712	H	0.39	0.4	0.57	0.42	0.36	–	–	–	–	–	0.33	0.68	0.58	0.42	–	0.3
199712	T	2.55	2.51	3.08	2.71	2.51	–	–	–	–	–	2.32	3.49	7.18	6.42	–	2.2
199812	H	–	0.4	0.45	0.44	0.41	0.32	–	–	–	–	–	0.55	0.55	0.38	–	–
199812	T	–	2.53	2.88	2.87	2.67	2.44	–	–	–	–	–	3.2	3.21	5.67	–	–
199912	H	–	0.31	0.47	0.5	0.36	0.33	0.33	–	–	–	–	0.56	0.43	–	–	–
199912	T	–	2.4	2.94	2.84	2.54	2.38	2.46	–	–	–	–	3.23	2.72	–	–	–
200012	H	–	0.38	0.47	0.48	0.44	0.36	0.35	0.35	–	–	–	0.54	0.54	0.39	–	–
200012	T	–	2.56	2.95	2.99	2.87	2.49	2.53	2.46	–	–	–	3.13	3.12	6.03	–	–
200109	H	–	0.31	0.49	0.4	0.36	0.38	–	–	–	–	–	0.73	0.64	–	–	–
200109	T	–	2.37	2.9	2.7	2.63	2.65	–	–	–	–	–	3.53	3.49	–	–	–
200212	H	0.33	0.43	0.46	0.4	0.32	–	–	–	–	–	–	0.61	0.53	–	–	–
200212	T	2.5	2.77	2.71	2.65	2.37	–	–	–	–	–	–	3.3	3.08	–	–	–
200312	H	–	0.37	0.52	0.46	0.35	–	–	–	–	–	–	0.8	0.62	0.42	–	–
200312	T	–	2.87	2.97	2.94	2.36	–	–	–	–	–	–	3.81	3.1	2.69	–	–
200412	H	0.34	0.3	0.52	0.48	0.46	0.32	0.31	–	–	–	–	1.19	0.84	0.58	–	–
200412	T	2.35	2.25	2.91	2.89	2.85	2.35	2.26	–	–	–	–	4.58	8.139999	7.38	–	–
200510	H	–	0.38	0.36	0.39	–	–	0.3	–	–	–	–	0.57	0.47	–	–	–
200510	T	–	2.52	2.41	2.61	–	–	2.33	–	–	–	–	3.3	2.85	–	–	–
200611	H	0.33	0.38	0.41	0.44	0.38	0.32	0.32	–	–	–	–	0.72	0.92	0.71	–	–
200611	T	2.24	2.39	2.82	2.81	2.54	2.53	2.34	–	–	–	–	3.59	4.01	7.79	–	–
200712	H	0.31	0.48	0.49	0.44	0.39	–	–	–	–	–	–	0.67	0.74	0.43	–	–
200712	T	2.19	2.84	2.95	2.78	2.54	–	–	–	–	–	–	3.61	3.58	2.84	–	–
200812	H	–	0.39	0.57	0.48	0.42	0.35	–	–	–	–	–	1.12	0.71	0.3	–	–
200812	T	–	2.83	3.08	2.94	2.69	2.52	–	–	–	–	–	4.42	3.6	2.19	–	–
200911	H	0.33	0.43	0.52	0.55	0.34	–	–	–	–	–	–	0.46	0.5	0.35	–	–
200911	T	2.73	2.89	2.92	3.14	2.39	–	–	–	–	–	–	2.78	2.9	2.47	–	–

H：波高(m)　T：周期(s)

(2)　確率波の算定

年最大波より確率統計処理を行い、M2 地点及び M3 地点各々の波向 WNW、NW.NNW,N,NNE,NE,ENE の 7 方位について、確率波高を算出した。算出結果の一例として、M2 地点、波向 WNW を図 5-12 に示す。(付属資料 1 参照)。また、周期については図 5-13 及び図 5-14 に示す年最大値波高と周期の相関図より算出した。相関図作成にあたっては、インド洋から(SW, SSW 方向）の波向については、対象地点への影響が小さいので除外している。以上により算出した確率波を表 5-12 に整理した。

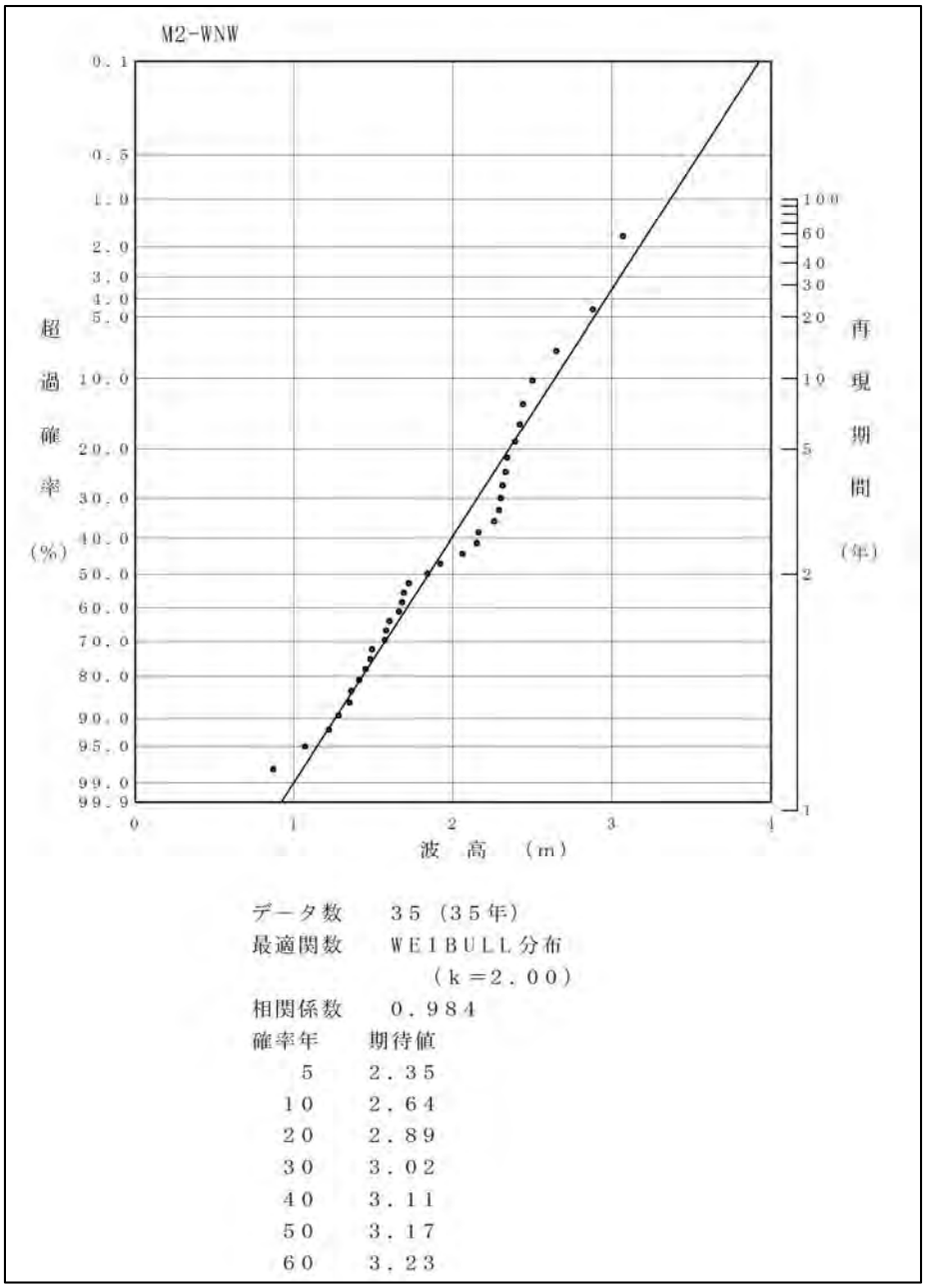


図 5-12　確率波高算出結果（地点 M2、WNW）

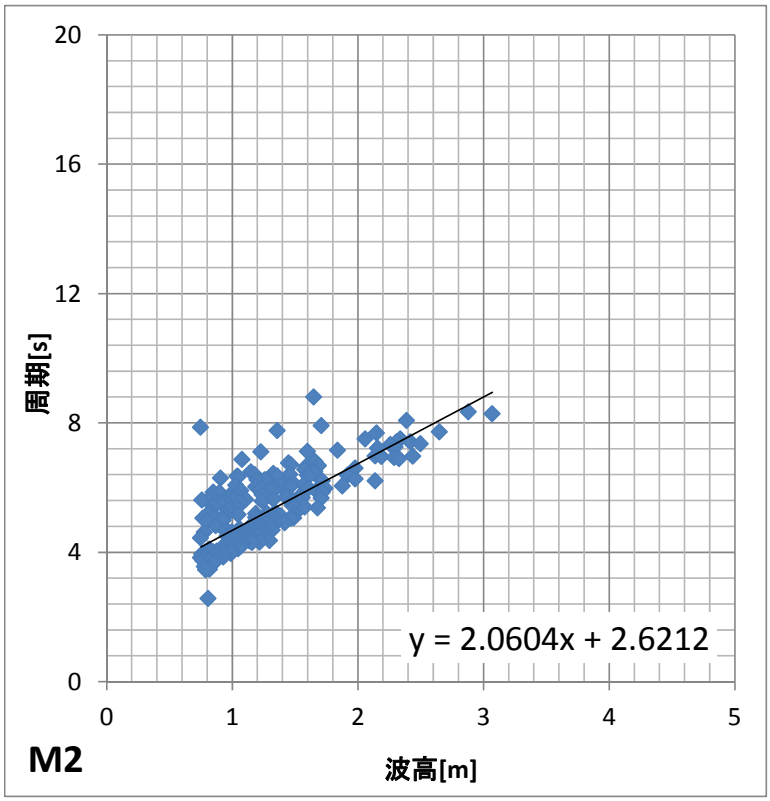


図 5-13　年最大値波高と周期の相関図（地点 M2）

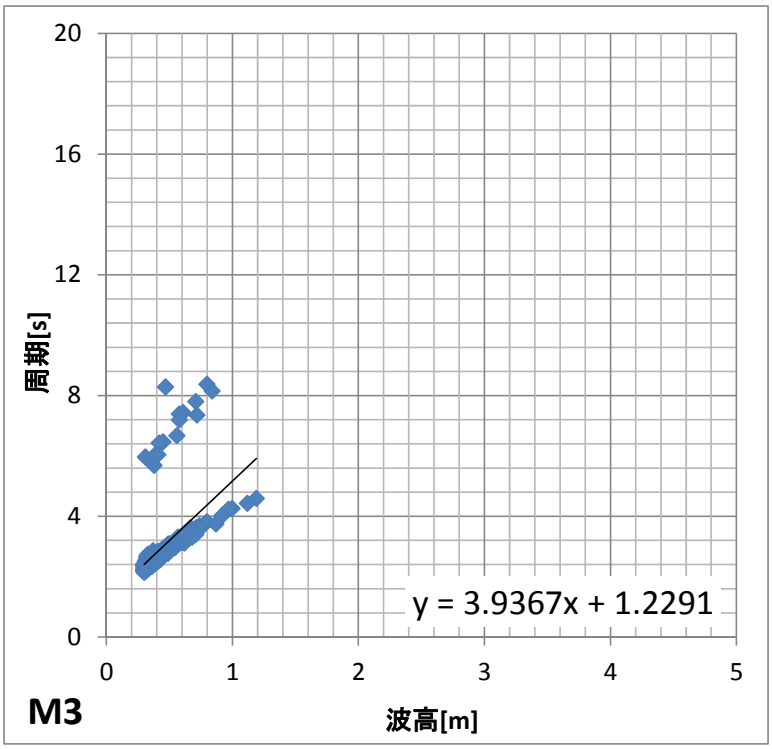


図 5-14　年最大値波高と周期の相関図（地点 M3）

表 5-12　確率波算出結果

波浪資料	波向	確率波（地点M2）				抽出条件
		5年	10年	30年	50年	
NOAA（地点M2）	WNW	2.35 m	2.64 m	3.02 m	3.17 m	0.75m以上
		7.5 s	8.1 s	8.8 s	9.2 s	
	NW	1.36 m	1.51 m	1.70 m	1.78 m	
		5.4 s	5.7 s	6.1 s	6.3 s	
	NNW	1.23 m	1.43 m	1.70 m	1.81 m	
		5.2 s	5.6 s	6.1 s	6.4 s	
	N	1.07 m	1.28 m	1.57 m	1.70 m	
		4.8 s	5.3 s	5.9 s	6.1 s	
	NNE	0.48 m	0.56 m	0.71 m	0.79 m	0.3m以上
		3.6 s	3.8 s	4.1 s	4.2 s	
	NE	0.47 m	0.51 m	0.56 m	0.58 m	
		3.6 s	3.7 s	3.8 s	3.8 s	
	ENE	0.73 m	0.81 m	0.92 m	0.98 m	
		4.1 s	4.3 s	4.5 s	4.6 s	

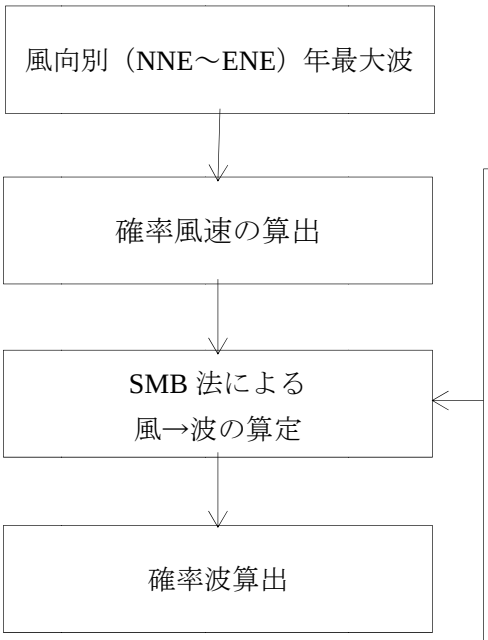
波浪資料	波向	確率波（地点M3）				抽出条件
		5年	10年	30年	50年	
NOAA（地点M3）	WNW	0.71 m	0.79 m	0.93 m	0.99 m	0.3m以上
		4.0 s	4.3 s	4.9 s	5.1 s	
	NW	0.48 m	0.56 m	0.66 m	0.71 m	
		3.1 s	3.4 s	3.8 s	4.0 s	
	NNW	データ不足により算定不可				
	N	0.30 m	0.31 m	0.33 m	0.33 m	
		2.4 s	2.4 s	2.5 s	2.5 s	
	NNE	0.33 m	0.35 m	0.38 m	0.39 m	
		2.5 s	2.6 s	2.7 s	2.8 s	
	NE	0.45 m	0.48 m	0.53 m	0.55 m	
		3.0 s	3.1 s	3.3 s	3.4 s	
	ENE	0.54 m	0.59 m	0.64 m	0.66 m	
		3.4 s	3.6 s	3.7 s	3.8 s	

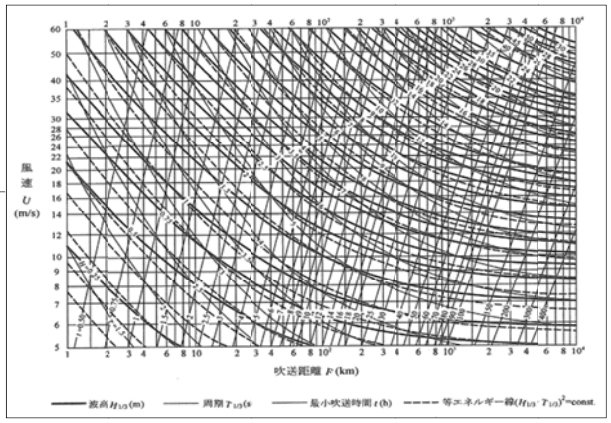
5-2-1-2-2　　風波による確率波

表 5-12 に示した通り、波浪推算による M2、M3 地点での NNE～ENE 方向の確率波は、50 年確率波で 1.0m 未満の結果である。この結果は設計波算出にあたって過小である可能性があるので、ここでは、NNE～ENE 方向について SMB 法により確率波を算定した。

(1)　算出方法

M1 地点における確率波（NNE～ENE）は以下のフローチャートにより算出した。





出典：港湾の施設の技術上の基準・同解説（平成 19 年 7 月）p.141

図 5-15　波浪予知曲線（SMB 法）

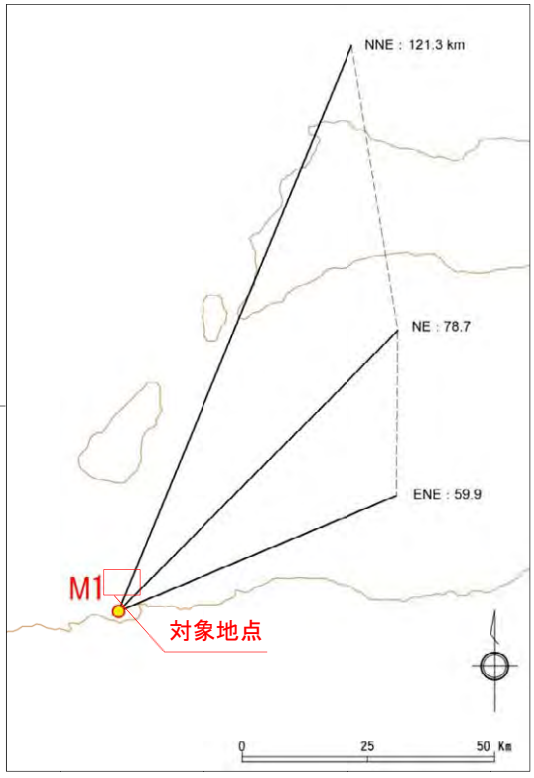


図 5-16　有効吹送距離

(2)　年最大値の算出

地点 M3 の再解析風資料より、各地点における波向別年最大風速を算出し、表 5-13 に整理した。

表 5-13　波向別年最大風速（地点 M3）

	設計波対象方向												設計波対象方向			
波向 / 取得年月	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247.5	270	292.5	315	337.5	360
	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
198012	5.09	7.1	7.01	6.86	6.76	5.58	4.35	–	–	3.2	709	7.56	7.22	5.04	4.63	4.94
198112	5	5.97	6.07	5.99	5.6	5.15	4.09	–	–	3.45	625	8.03	7.17	6.73	4.74	5.2
198212	5.4	5.77	6.58	6.85	6.4	5.39	4.53	–	–	3.87	458	6.34	7.18	5.43	5.11	5.53
198312	5.23	5.38	6.43	6.4	6.32	6.78	4.76	3.1	3.32	–	4.4	4.49	5.49	5.23	5.45	4.83
198412	5.14	6.68	6.77	6.27	6.14	5.5	4.63	–	–	4.19	553	6.52	5.43	5.38	4.88	5.38
198512	5.17	5.13	5.49	6.38	6.35	5.37	4.48	–	–	3.41	448	7.65	7.06	4.72	5.35	5.06
198612	5.07	5.39	6.06	7.13	5.68	5.12	4.59	4.03	–	5.66	4.9	9.11	8.58	5.19	4.31	5.45
198712	5.92	6.29	6.46	6.68	6.05	5.32	4.01	–	–	–	488	7.79	9.01	6.12	4.12	5.54
198812	5.7	5.85	6.69	6.73	5.65	5.65	4.61	–	4.31	4.68	586	7.25	6.07	5.4	4.84	4.86
198912	4.8	6.08	7.22	5.76	5.34	5.18	4.59	3.42	3.47	5.55	648	6.76	7.25	6.36	4.87	5.32
199012	5.79	6.42	7.49	6.3	6.28	5.01	4.65	3.24	3.01	4.29	713	7.74	6.24	5.18	5.66	4.86
199112	5.49	6.79	7.22	5.86	5.32	5.26	4.37	–	–	–	469	5.95	6.14	5.43	4.69	5.21
199212	5.63	6.78	7.47	6.31	5.31	5.11	4.13	3.5	–	3.7	535	6.21	6.58	6.85	5.04	5.2
199312	5.72	6.7	7.15	8.35	6.56	5.42	5.35	–	3.96	3.39	639	8.44	6.99	6.63	4.71	4.57
199412	5.45	5.43	6.51	6.49	6.95	5.58	4.71	3.05	–	–	319	6.16	6.63	7.49	5.18	5.03
199512	4.89	6.04	6.84	6.06	6.2	5.48	4.7	3.12	–	3.35	583	7.5	6.01	4.76	5	4.97
199612	4.91	5.98	5.59	5.33	5.74	4.9	4.53	–	4.33	4.66	636	7.16	6.59	5.22	4.84	5.09
199712	5.54	6.37	7.26	6.51	5.58	5.65	4.63	–	–	4.07	737	7.68	6.52	5.27	4.71	4.82
199812	4.98	5.72	6.21	6.1	5.76	5.31	4.25	3.23	3.14	4.74	564	6.78	7.03	5.57	5.36	4.99
199912	4.79	5.47	6.49	6.77	5.24	5.34	4.86	3.1	–	–	4.5	6.89	5.18	5.35	3.98	4.24
200012	4.5	5.92	6.74	6.06	6.73	5.61	4.95	3.48	3.81	4.03	497	6.69	6.95	5.11	4.05	4.36
200112	4.93	5.03	6.5	5.73	5.64	5.63	4.93	–	3.02	3.38	718	7.85	7.01	5.02	4.18	4.1
200212	5.51	6.53	6.35	5.58	5.16	4.79	4.52	3.11	–	3.25	636	7.29	5.92	4.52	4.8	5
200312	5.38	5.95	6.87	6.07	6.14	4.89	4.57	–	–	4.34	791	8.47	9.22	5.81	4.3	4.75
200412	5.62	5.56	5.31	6.86	6.58	6.1	4.59	–	3.25	–	615	10.32	8.95	6.58	4.5	4.51
200512	4.99	5.39	6.04	5.81	5.31	4.84	4.79	–	–	4.21	668	6.99	5.95	5.16	4.19	5.18
200612	6.8	6.09	5.93	5.86	6.13	5.95	4.93	3.36	–	3.48	612	7.8	8.69	5.78	5.22	8.7
200712	5.14	6.36	6.73	6.16	5.66	5.3	4.74	–	–	3.05	539	8.24	7.73	6.1	5.15	4.8
200812	5.28	6.25	7.18	6.69	5.9	5.94	5.1	–	–	3.77	10.19	10.46	7.71	5.87	5.04	4.32
200912	5.29	6.32	6.93	6.83	6.17	5.03	4.2	3.23	–	3.01	498	6.05	6.24	5.11	4.32	4.62
201012	4.86	4.19	5.59	6.55	7.65	7.34	5.62	3.92	3.13	4	584	7.21	7.8	6.18	6.05	4.43
201112	5.39	4.76	6.77	7.13	6.67	7.21	5.72	–	3.88	5.51	672	6.73	5.61	6.43	6.7	5.54
201212	5.67	6.32	5.44	5.63	5.78	7.04	5.84	5.09	–	3.57	667	7.15	6.29	6.8	5.2	5.51
201312	5.06	5.47	6.11	6.21	6.81	7.14	5.83	3.64	3.88	4.71	672	6.78	8.14	5.94	6.11	5.01
201412	6.09	5.73	6.5	6.58	6.94	6.74	5.25	–	3.31	6.17	764	7.92	8.09	5.74	5.98	6.06

単位(m)

(3)　確率波の算定

年最大風速より確率統計処理を行ない、M2 地点及び M3 地点における風向 NNE、NE、ENE の 3 位の確率風速を算出した。算出結果の一例を図 5-17 に示す（付属資料２参照）。

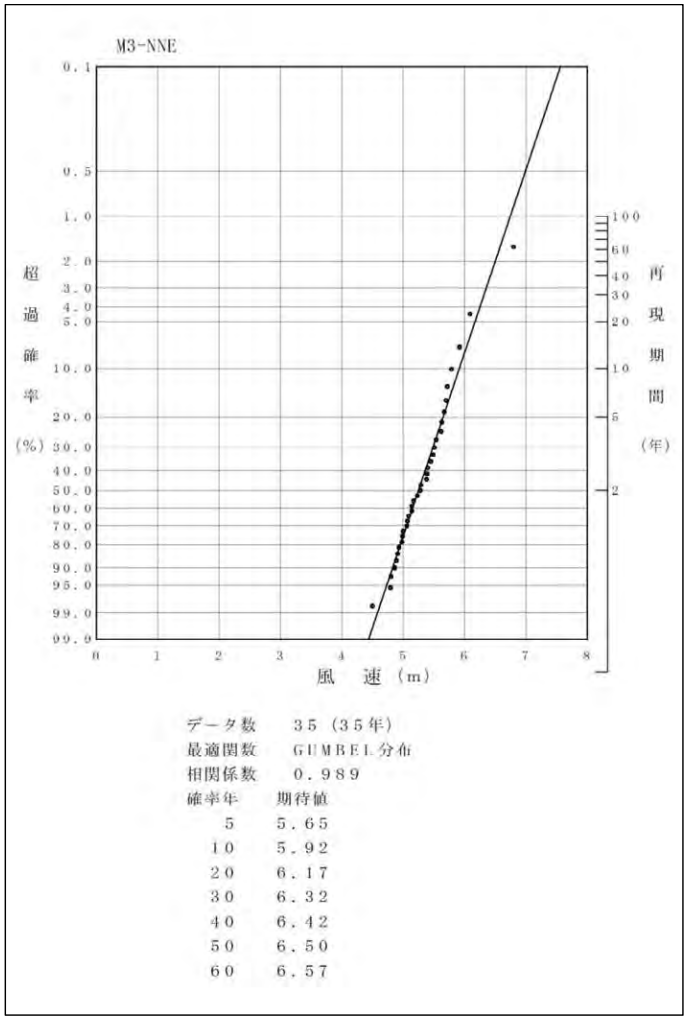


図 5-17　確率風速算出結果（地点 M3、NNE）

表 5-14　確率波算出結果

波向	確率年	確率風速 (m/s)	吹送距離 (km)	沖波波高 (m)	周期 (s)	沖波波長 (m)	波形勾配	Smax
NNE	50	6.50	121.3	0.80	3.8	22.5	0.036	10
	30	6.32	121.3	0.80	3.7	21.4	0.037	10
	10	5.92	121.3	0.70	3.6	20.2	0.035	10
	5	5.65	121.3	0.70	3.4	18.0	0.039	10
NE	50	7.36	78.7	0.90	3.8	22.5	0.040	10
	30	7.18	78.7	0.90	3.7	21.4	0.042	10
	10	6.75	78.7	0.80	3.6	20.2	0.040	10
	5	6.43	78.7	0.70	3.5	19.1	0.037	10
ENE	50	7.88	59.9	0.90	3.8	22.5	0.040	10
	30	7.72	59.9	0.90	3.7	21.4	0.042	10
	10	7.31	59.9	0.80	3.6	20.2	0.040	10
	5	6.99	59.9	0.80	3.5	19.1	0.042	10

5-2-1-2-3　　確率波算定結果

以上の結果を図 5-14 及び図 5-18 に整理した。

波浪資料による確率波算定結果（M3 地点）では、50 年確率波で、全方向とも 1.0m 以下となっている。このことは、M3 地点が浅海域であり、またアタウロ島とティモール島に囲まれており、精度良く推算されていない可能性が高いためと考えられる。

また、M2 地点の NNE～ENE 方向の推算結果は、風資料からの推算結果と同じような値であるが、アタウロ島の回折により波浪が減衰すると考えられることから、以降の検討は M2 地点での推算結果 WNW～N 方向と、風資料からの推算結果 NNE～ENE を採用とした。

表 5-15　確率波算定結果一覧表

	波向	5年	10年	30年	50年	抽出条件	資料
確率波（地点M2）	WNW	2.35 m	2.64 m	3.02 m	3.17 m	0.75m以上	波浪資料 NOAA（地点M2）
		7.5 s	8.1 s	8.8 s	9.2 s		
	NW	1.36 m	1.51 m	1.70 m	1.78 m		
		5.4 s	5.7 s	6.1 s	6.3 s		
	NNW	1.23 m	1.43 m	1.70 m	1.81 m		
		5.2 s	5.6 s	6.1 s	6.4 s		
	N	1.07 m	1.28 m	1.57 m	1.70 m		
		4.8 s	5.3 s	5.9 s	6.1 s		
	NNE	0.48 m	0.56 m	0.71 m	0.79 m	0.3m以上	
		3.6 s	3.8 s	4.1 s	4.2 s		
	NE	0.47 m	0.51 m	0.56 m	0.58 m		
		3.6 s	3.7 s	3.8 s	3.8 s		
	ENE	0.73 m	0.81 m	0.92 m	0.98 m		
		4.1 s	4.3 s	4.5 s	4.6 s		
確率波（地点M3）	WNW	0.71 m	0.79 m	0.93 m	0.99 m	0.3m以上	波浪資料 NOAA（地点M3）
		4.0 s	4.3 s	4.9 s	5.1 s		
	NW	0.48 m	0.56 m	0.66 m	0.71 m		
		3.1 s	3.4 s	3.8 s	4.0 s		
	NNW	データ不足により算定不可					
	N	0.30 m	0.31 m	0.33 m	0.33 m		
		2.4 s	2.4 s	2.5 s	2.5 s		
	NNE	0.33 m	0.35 m	0.38 m	0.39 m		
		2.5 s	2.6 s	2.7 s	2.8 s		
	NE	0.45 m	0.48 m	0.53 m	0.55 m		
		3.0 s	3.1 s	3.3 s	3.4 s		
	ENE	0.54 m	0.59 m	0.64 m	0.66 m		
		3.4 s	3.6 s	3.7 s	3.8 s		
確率波（地点M1）	NNE	0.70 m	0.70 m	0.80 m	0.80 m	–	風資料 NOAA（地点M3）
		3.4 s	3.6 s	3.7 s	3.8 s		
	NE	0.70 m	0.80 m	0.90 m	0.90 m		
		3.5 s	3.6 s	3.7 s	3.8 s		
	ENE	0.80 m	0.80 m	0.90 m	0.90 m		
		3.5 s	3.6 s	3.7 s	3.8 s		

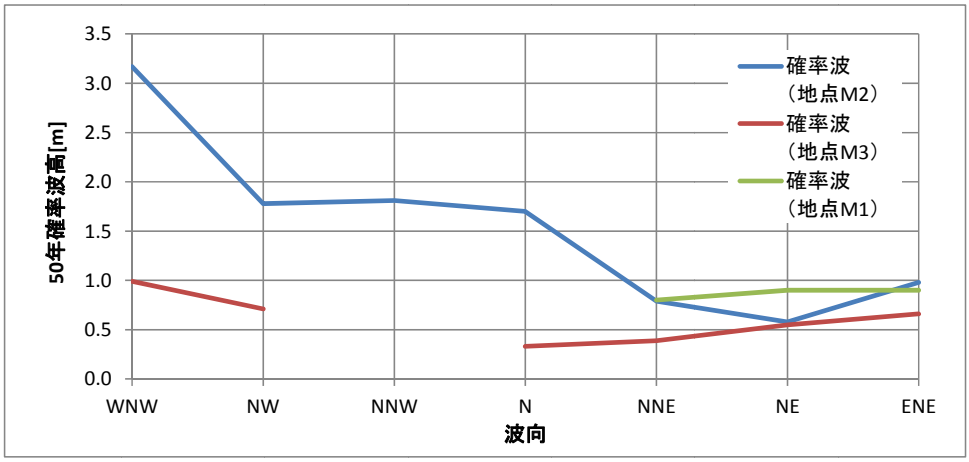


図 5-18　50 年確率波高

5-2-1-3 ディリ港付近の設計波諸元

前項で求めた確率波（WNW～N）は地点 M2 であるため、ここでは M2 地点の確率波を波浪変形して M1 地点での波を求めた。

5-2-1-3-1　　手法

波浪変形計算はエネルギー平衡方程式を用いる。エネルギー平衡方程式の基礎方程式は付属資料３に示す。

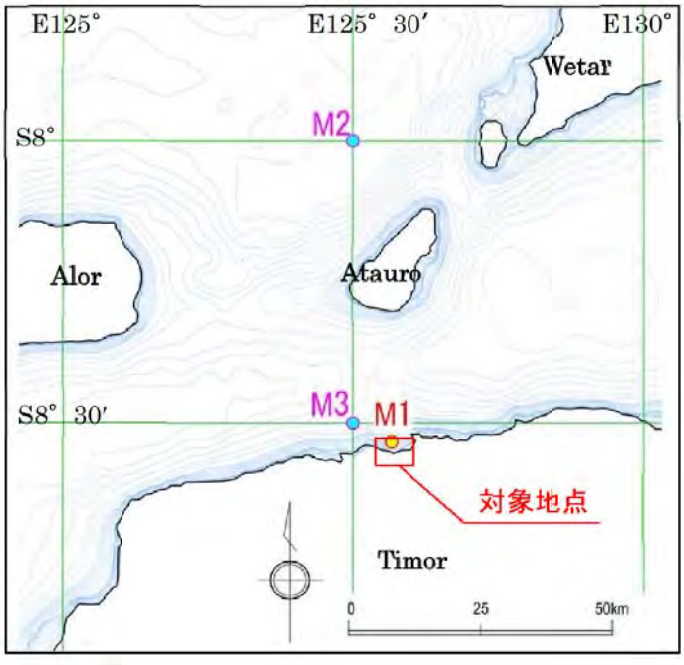


図 5-19　地点 M1 位置図

5-2-1-3-2　　条件

(1)　波浪条件

波浪条件は表 5-15 に示す確率波算定結果一覧より、表 5-16 に示す 50 年確率波とした。

表 5-16　沖波条件

50年確率波（地点M2）				
沖波向	WNW	NW	NNW	N
沖波波高	3.17 m	1.78 m	1.81 m	1.70 m
周期	9.2 s	6.3 s	6.4 s	6.1 s

(2)　水深及び地形

水深及び地形は下記に示した資料を使用した。

・海図 942A
・測量データ（貸与資料）
・GEBCO30（出典：http://www.gebco.net/）

(3)　潮位条件

前出の潮位条件より、HWL を使用する。

M.H.H.W=＋2.30m

(4)　計算範囲及び計算格子間隔

計算格子間隔 200m

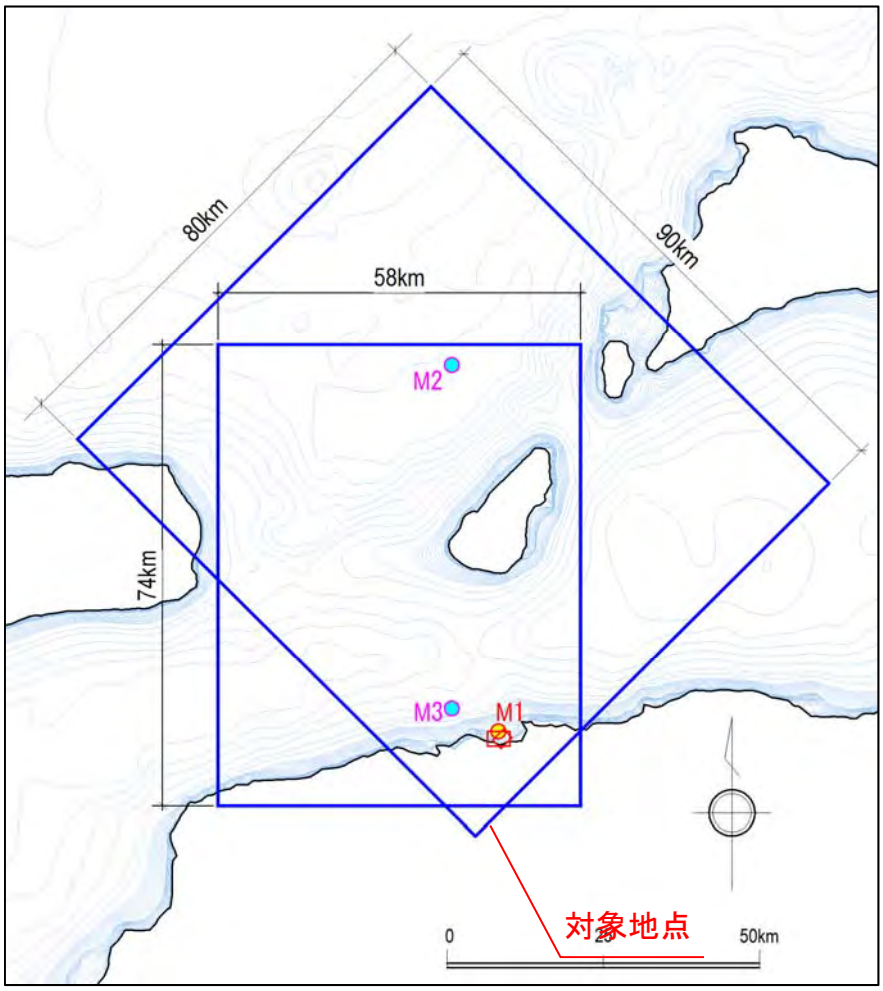


図 5-20　計算範囲

5-2-1-3-3　　結果

波向 WNW、NW、NNW の 3 方位について検討を行ったが、計算結果の一例として、波向 WNW の計算結果を図 5-21 から図 5-26 に示す。なお、全ケースの計算結果は付属資料 4 参照。計算結果より M1 地点での設計波諸元を求め、表 5-17 に整理した。

表 5-17　M1 地点設計沖波諸元（50 年確率波）

M2 地点設計沖波			M1 地点設計沖波			
波向	波高(m)	周期(s)	入射波向（°）	波高(m)	周期(s)	備考
WNW	3.17	9.2	324.0	1.63	9.2	波浪資料による値 外洋性波
NW	1.78	6.3	327.0	1.13	6.3	
NNW	1.81	6.4	330.0	1.17	6.4	
N	1.70	6.1	360.0	1.36	6.1	

波向は N から時計まわりの角度

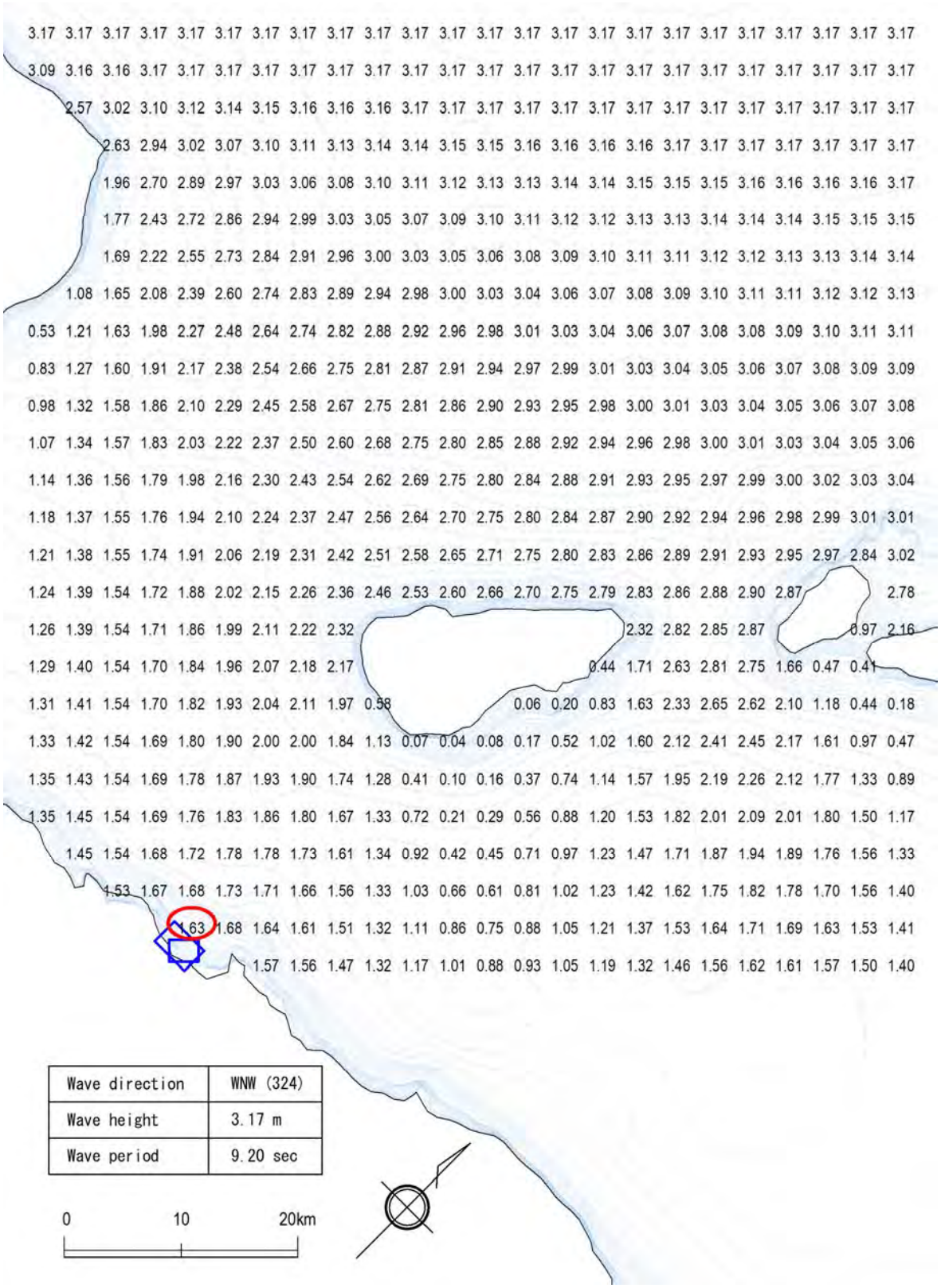


図 5-21　換算沖波波高分布（WNW）

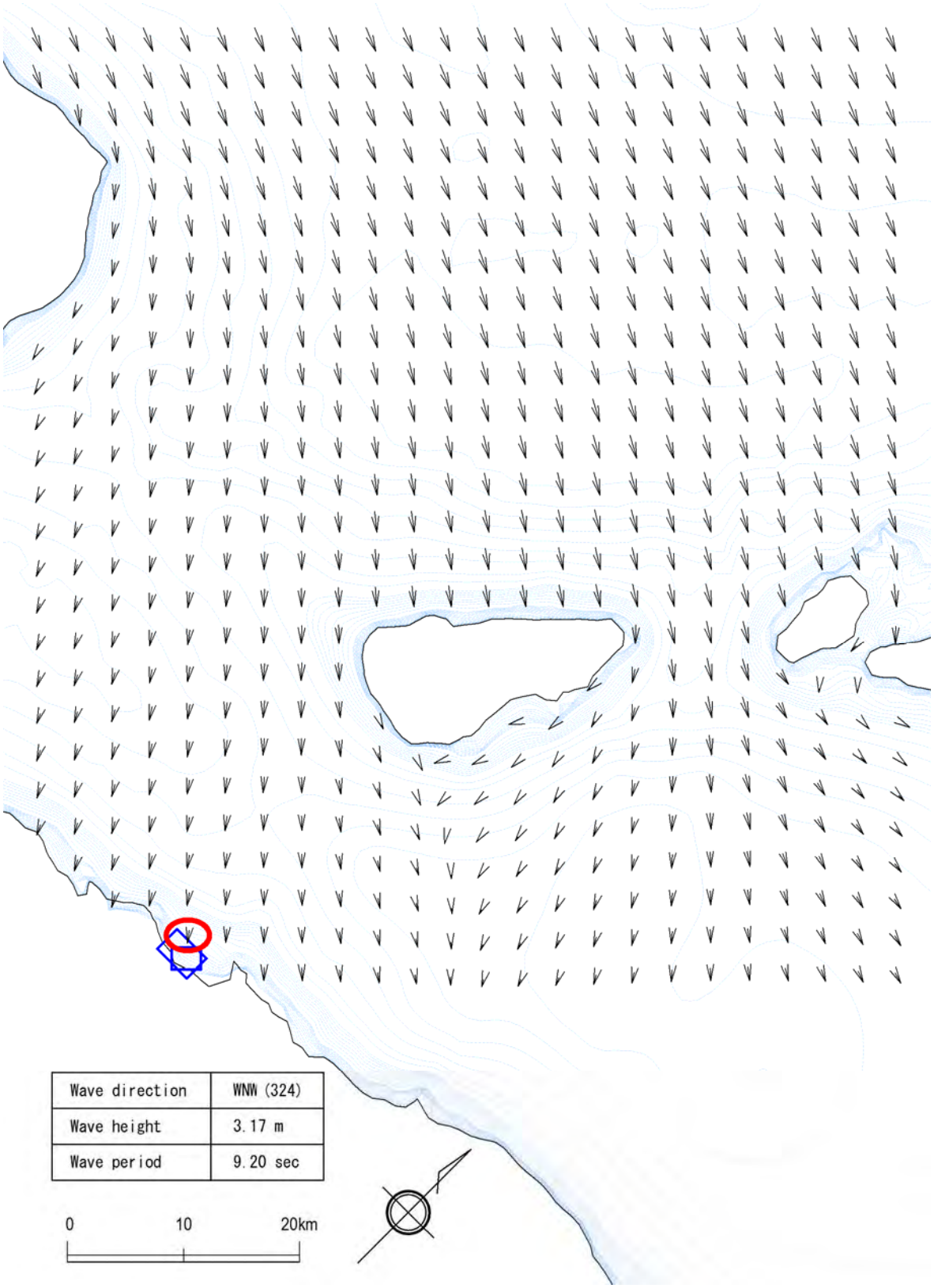


図 5-22　波向ベクトル分布（WNW）

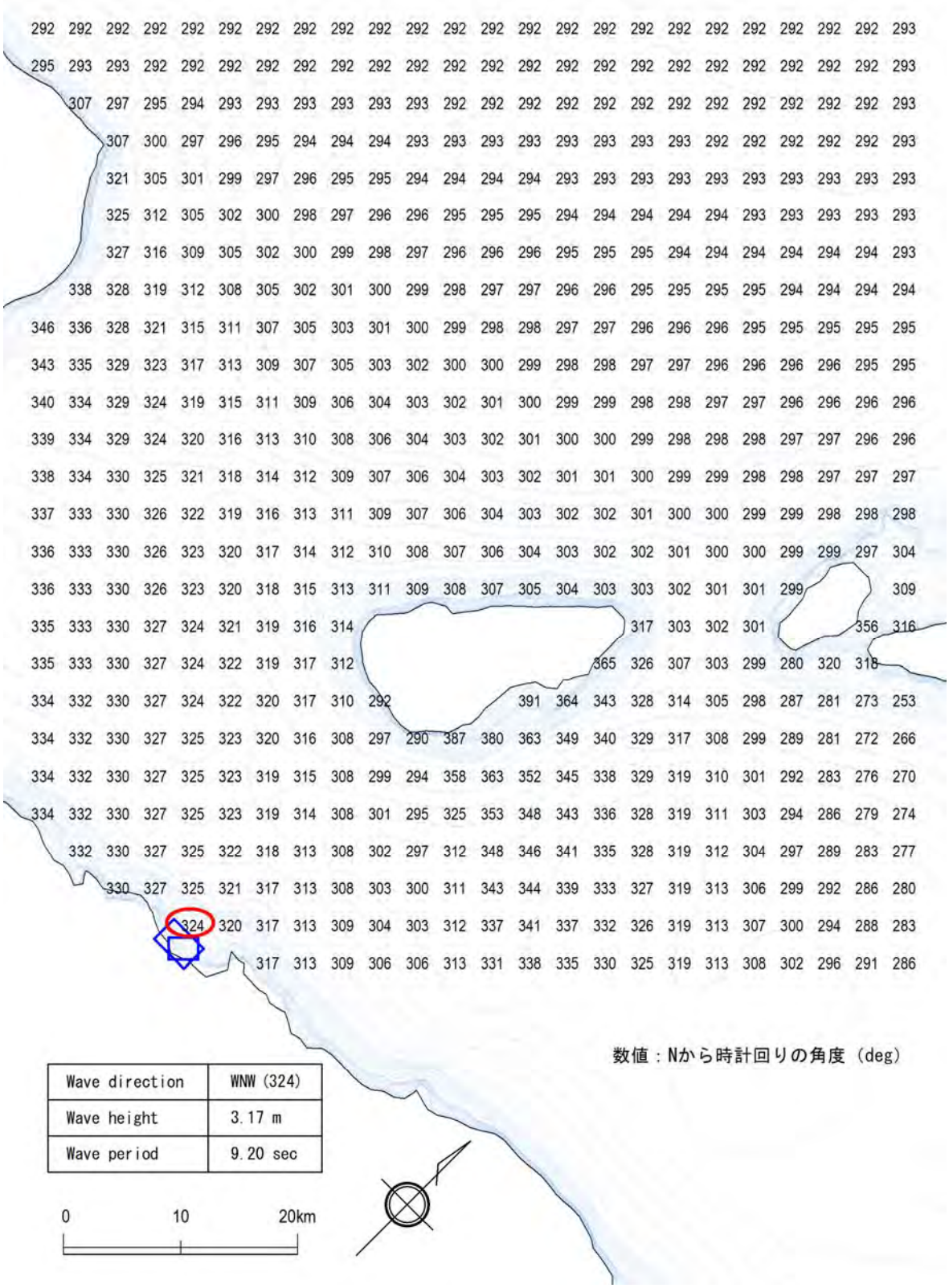


図 5-23　波向数値分布（WNW）

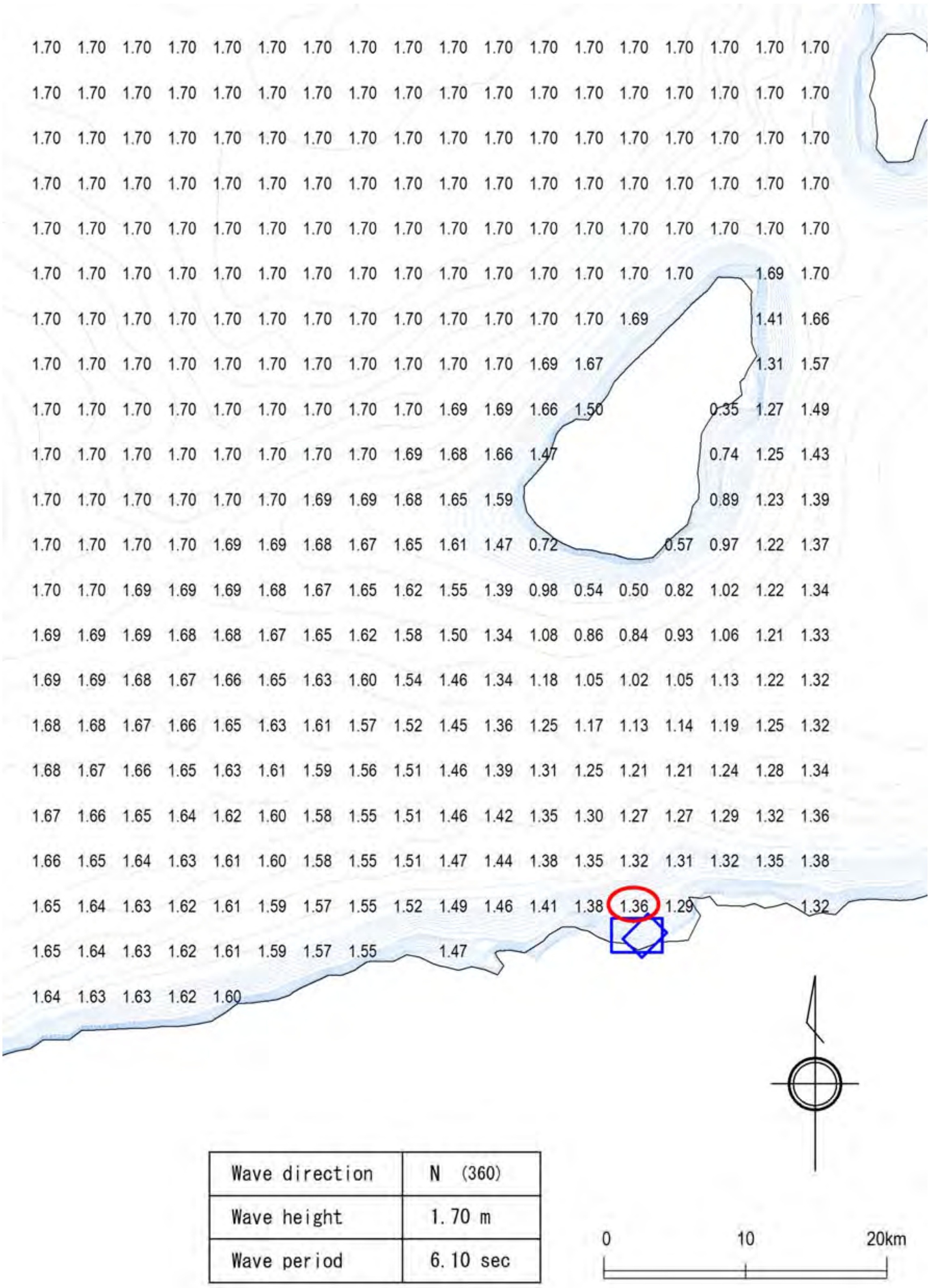


図 **5-24** 換算沖波波高分布（**N**）

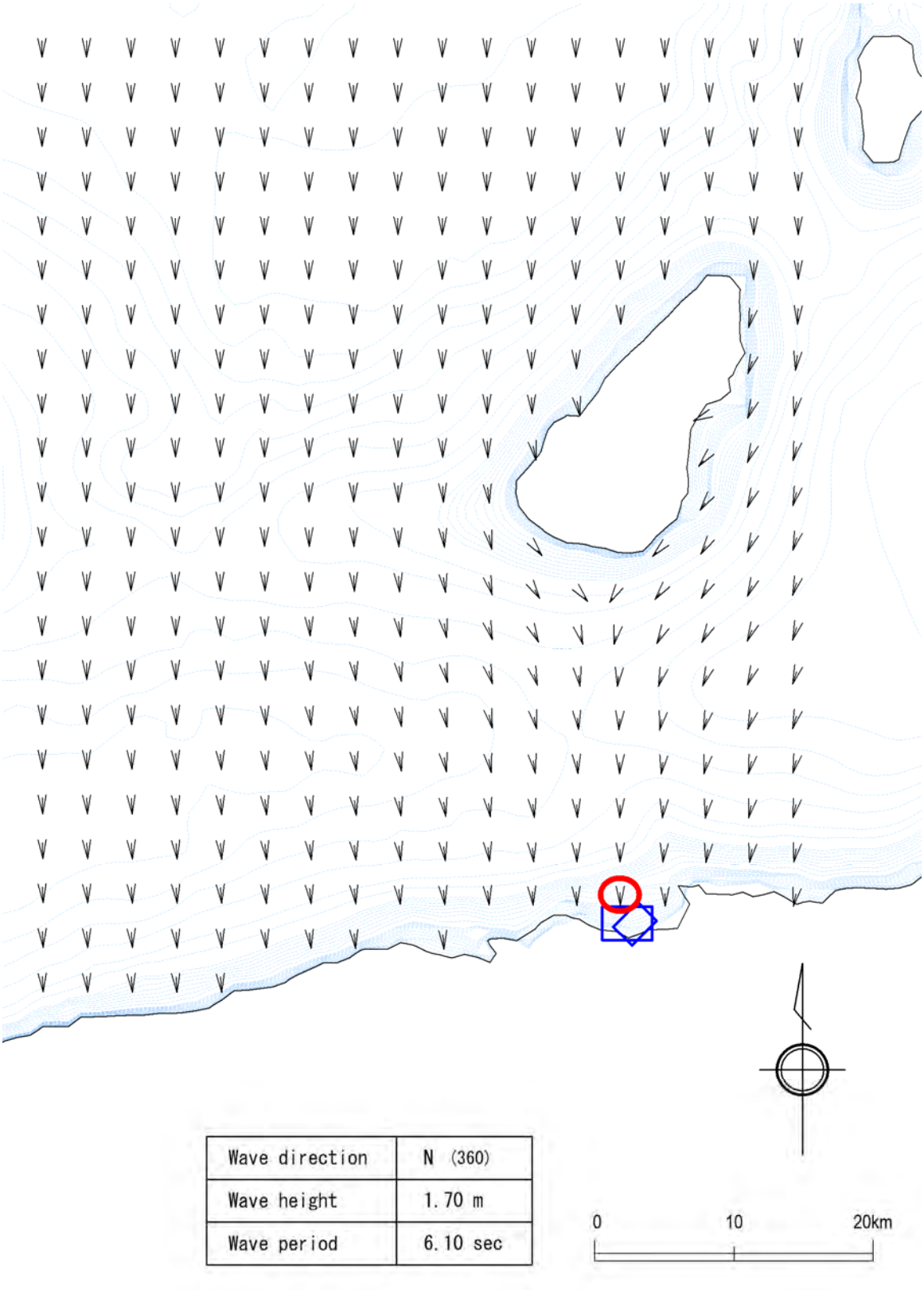


図 5-25　波向ベクトル分布（N）

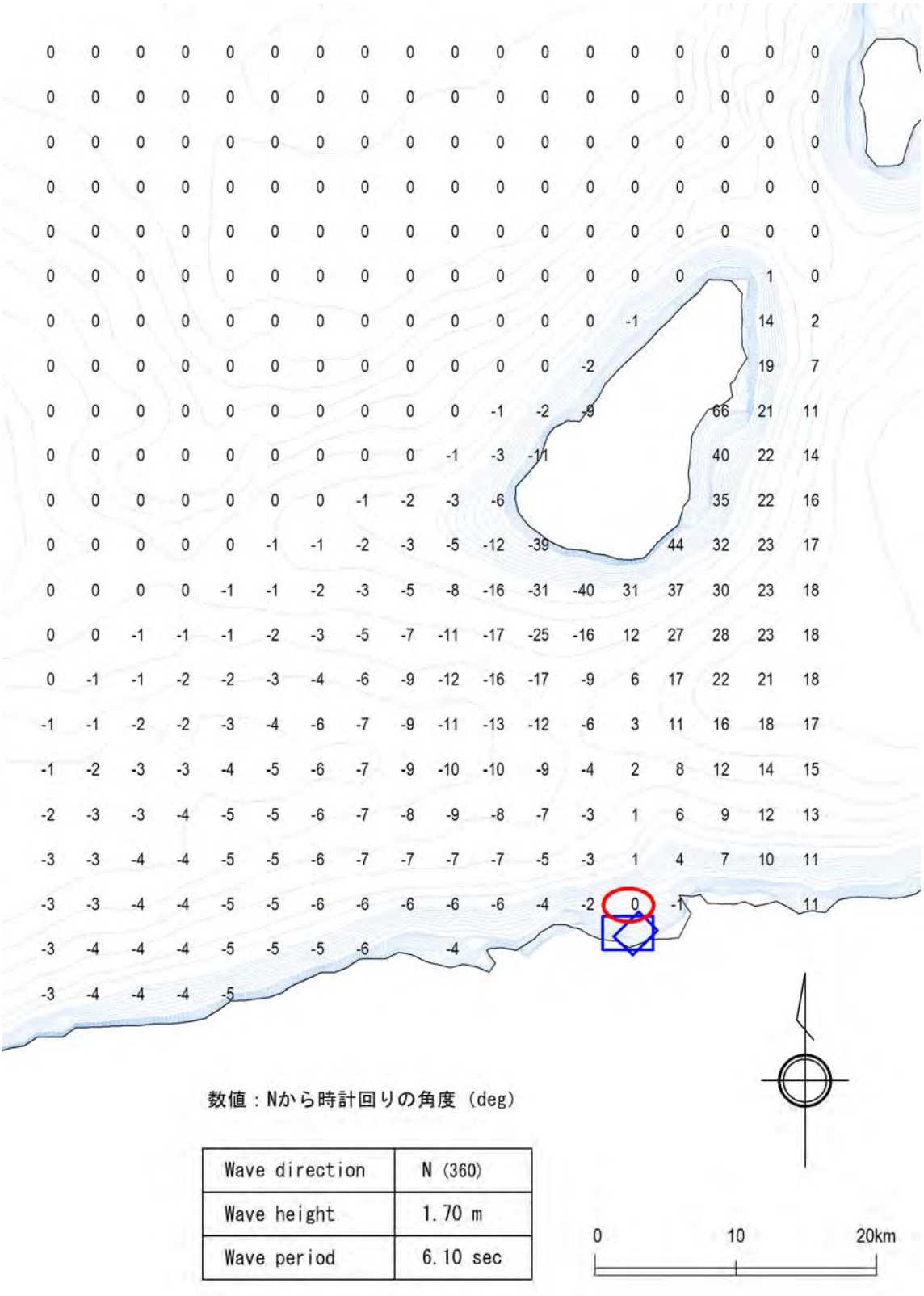


図 5-26　波向数値分布（N）

5-2-1-4 対象地点の設計波諸元

ここでは、M1 地点より設計対象地点での設計波諸元を求めた。

5-2-1-4-1 手法

手法は、エネルギー平衡方程式より算出した。

5-2-1-4-2 条件

(1) 波浪条件

M1 地点における波浪諸元を表 5-18 に整理した。

表 5-18 波浪諸元（地点 M1）

M1地点				備考
波向		波高(m)	周期(s)	
WNW	324.0	1.63	3.1	波浪資料による値 外洋性波
NW	327.0	1.13	6.3	
NNW	330.0	1.17	4.2	
N	360.0	1.36	6.1	
NNE	22.5	0.80	3.8	風資料による値
NE	45.0	0.90	3.8	
ENE	67.5	0.90	3.8	

波向はNから時計まわりの角度

(2) 水深及び地形

水深及び地形は下記に示した資料を使用した。

・海図 3296
・現地再委託調査による測量データ
・GEBCO30（出典：http://www.gebco.net/）

(3) 潮位条件

前項と同様、下記に示す M.H.H.W とする。

M.H.H.W=＋2.30m

(4)　計算範囲及び計算格子間隔

計算格子間隔 10m

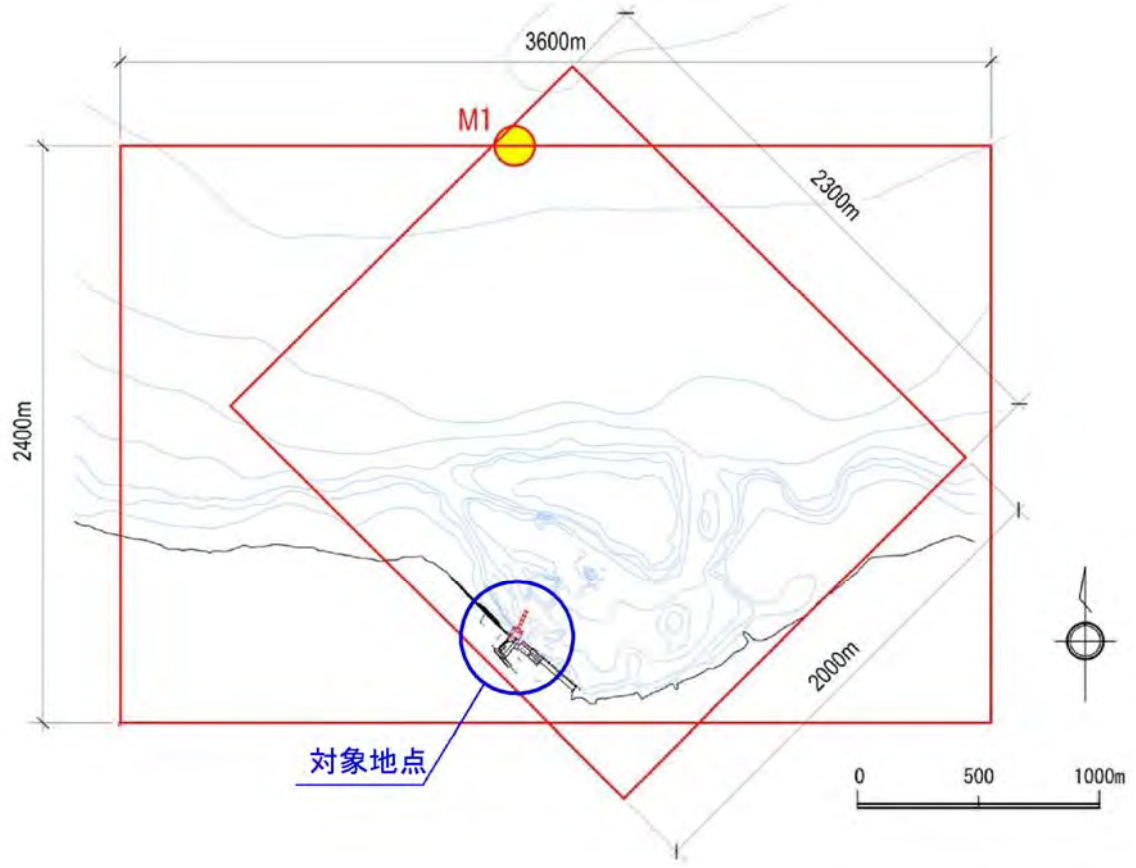


図 5-27　計算範囲

5-2-1-4-3　　結果

計算は、波向 WNW、NW、NNW、N、NNE、NE、ENE の 7 方位について行ったが、計算結果の一例として、波向 WNW の結果を図 5-28～図 5-33 に示す。なお、全てのケースの計算結果は付属資料 5 参照。

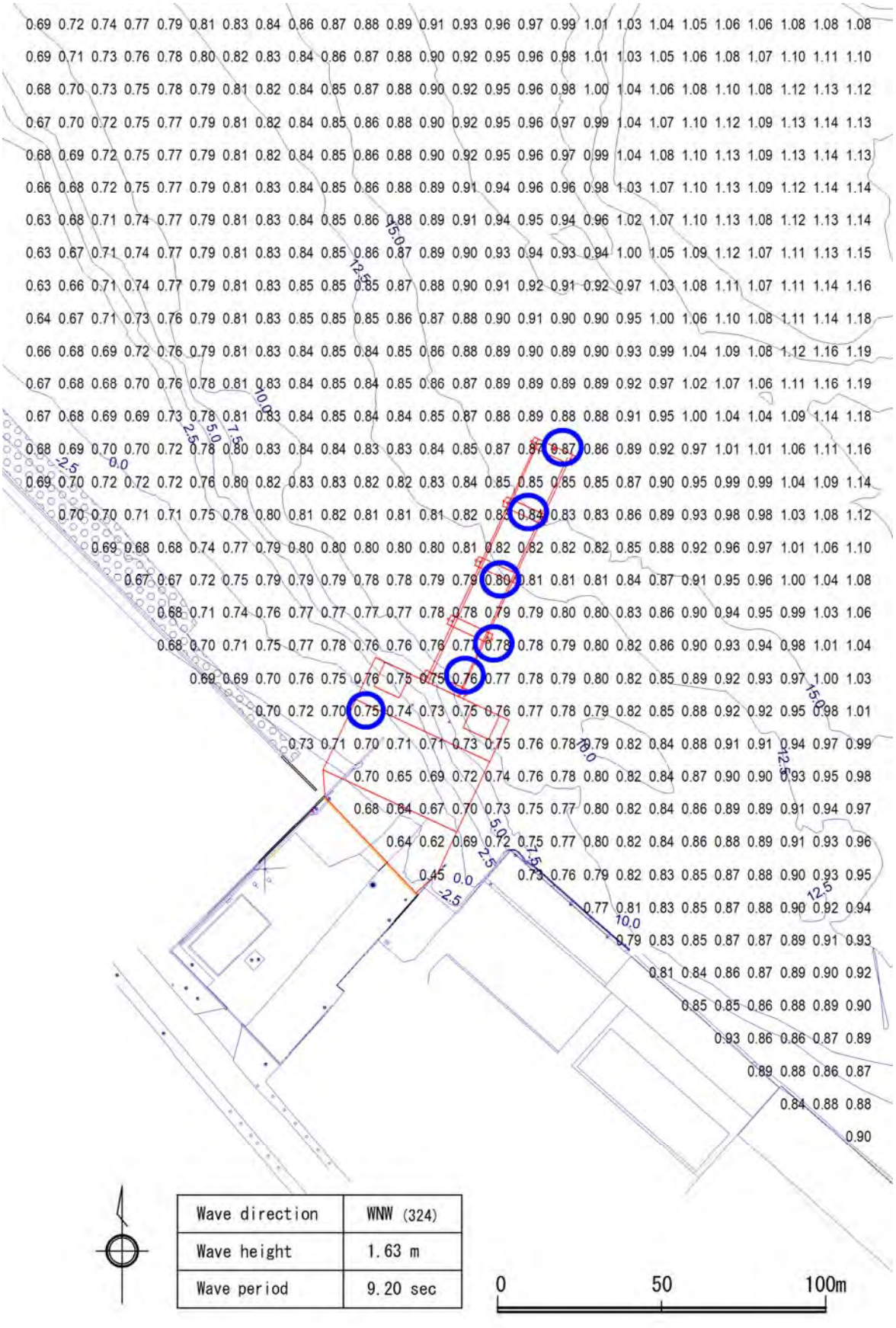


図 5-28　換算沖波波高分布（WNW）

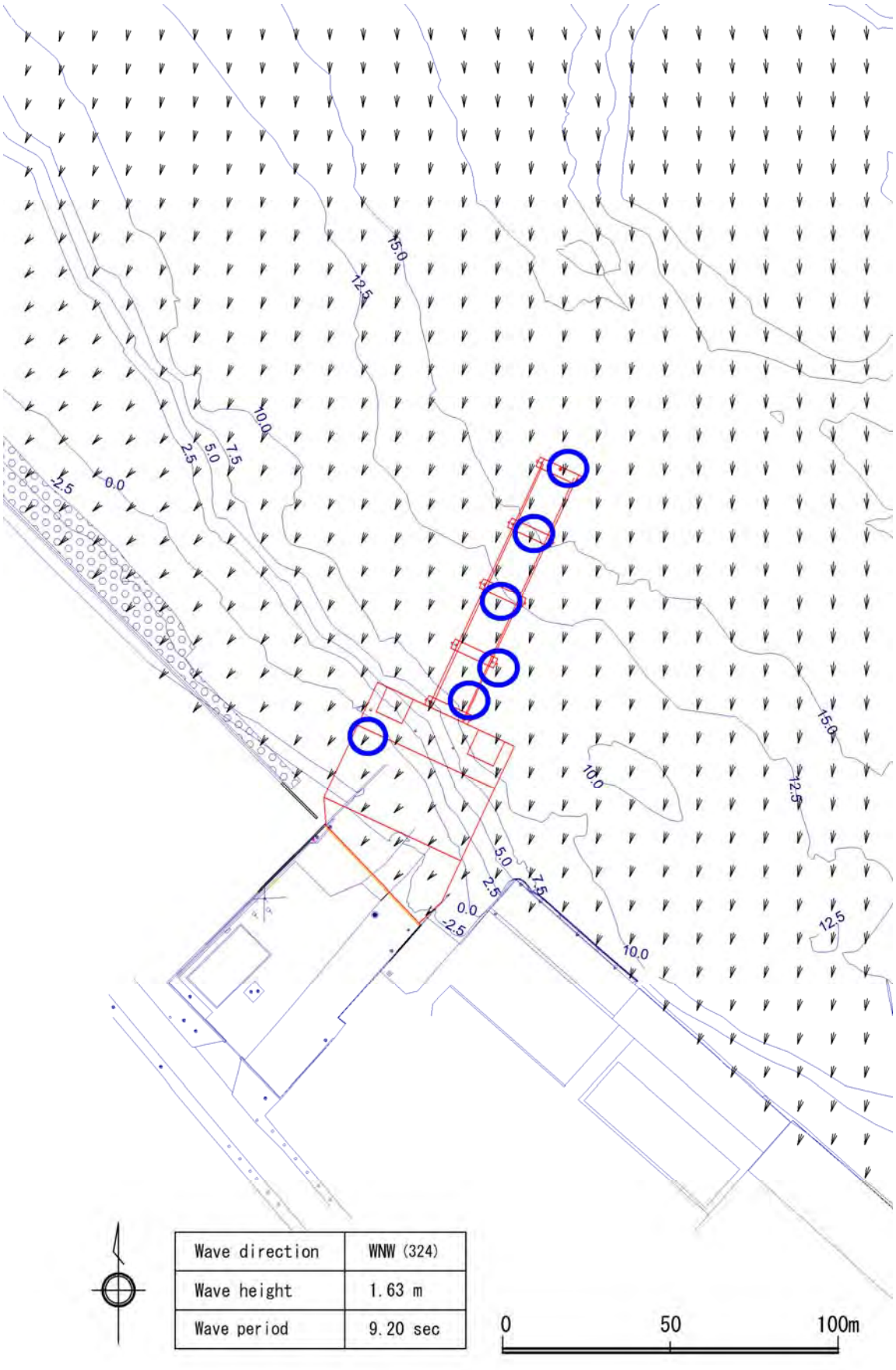


図 5-29　波向ベクトル分布（WNW）

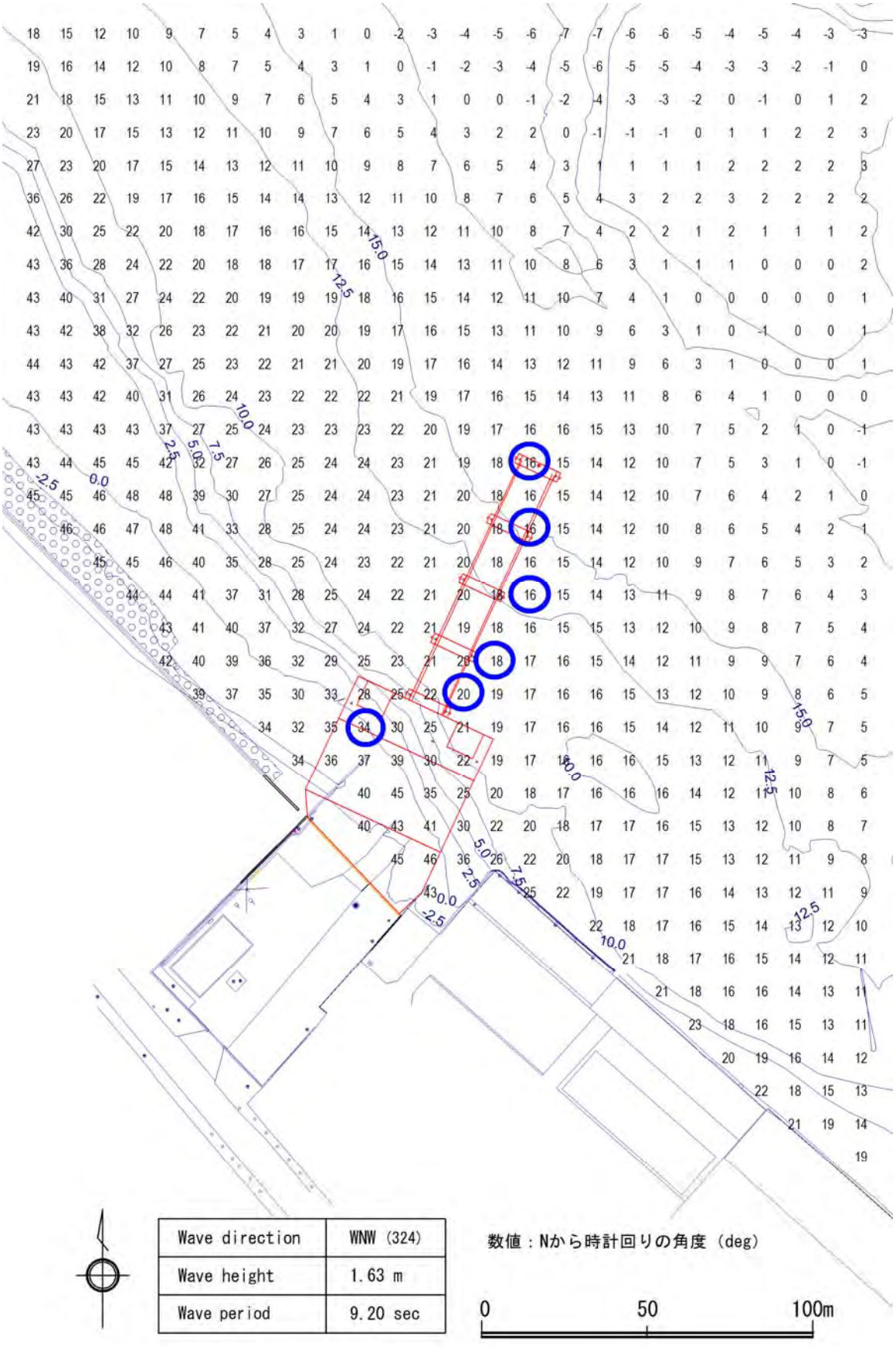


図 5-30　波向数値分布（WNW）

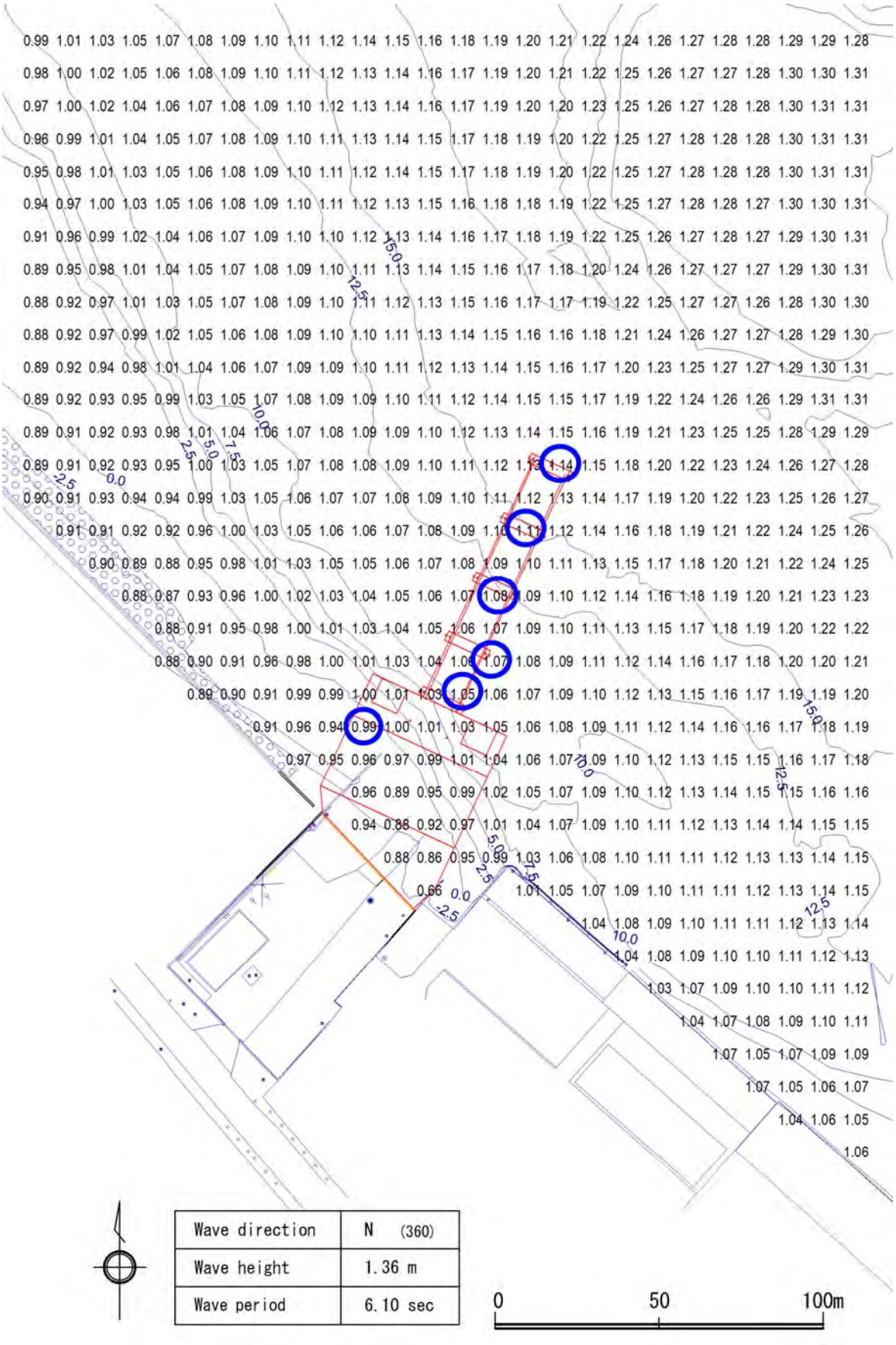


図 5-31　換算沖波波高分布（N）

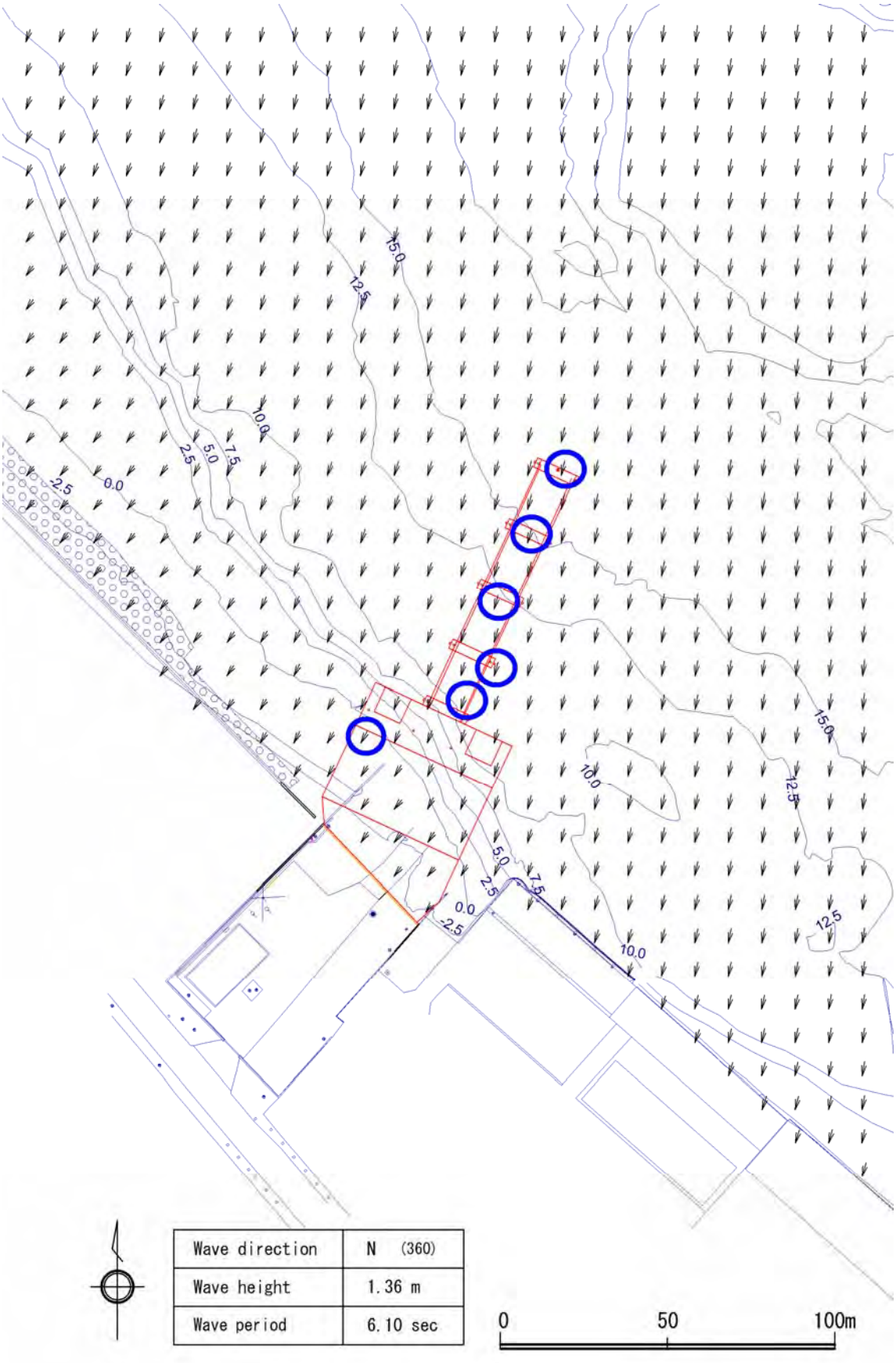


図 5-32　波向ベクトル分布（N）

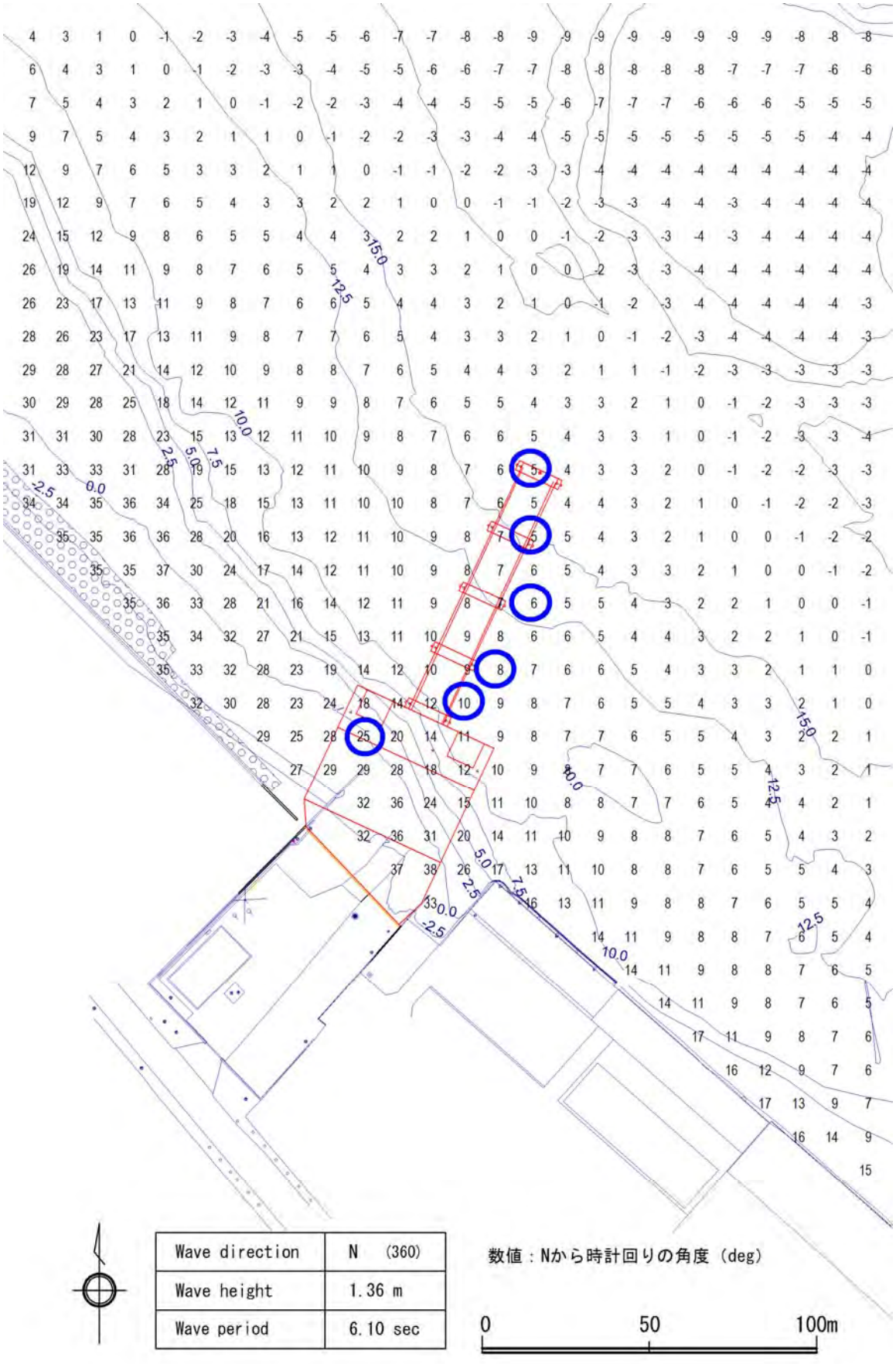


図 5-33　波向数値分布（N）

算出した換算沖波波高分布より $H_{1/3}$，H_{max} を表 5-19、表 5-20 に整理した。算出例を図 5-35 に示す。また同表より水深と $H_{1/3}$，H_{max} の関係を図 5-34 に整理した。

同図によれば、浅海域においては $H_{1/3}$，H_{max} 共に WNW が高く、それ以外の水深では N が高い値を示している。よってこれ以降の波頂高の検討については、N，WNW を対象とする。

表 5-19　換算沖波波高，$H_{1/3}$，H_{max} 一覧

M2波向(°)		波高(m)	周期(s)	潮位(m)	Lo	勾配 (1/x x=)	水深 h(m)	Ho'(m)	H1/3(m)	Hmax(m)
WNW	324	3.17	9.2	2.30	132.04	10	16.0	0.87	0.80	1.40
							15.0	0.84	0.80	1.40
							12.5	0.80	0.70	1.30
							11.5	0.78	0.70	1.30
							10.0	0.76	0.70	1.30
							9.0	0.76	0.70	1.30
							8.0	0.76	0.70	1.30
							7.0	0.76	0.70	1.30
							6.0	0.76	0.70	1.30
							5.0	0.76	0.80	1.40
							4.0	0.76	0.80	1.40
							3.0	0.76	0.80	1.50
							2.0	0.76	0.80	1.50
							1.0	0.76	0.90	1.70
							0.0	0.76	1.20	2.10
							−1.0	0.76	1.30	1.80
							−2.0	0.76	0.50	0.80
NW	327	1.78	6.3	2.30	61.92	10	16.0	0.70	0.70	1.20
							15.0	0.68	0.60	1.20
							12.5	0.66	0.60	1.10
							11.5	0.64	0.60	1.10
							10.0	0.63	0.60	1.00
							9.0	0.61	0.60	1.00
							8.0	0.61	0.60	1.00
							7.0	0.61	0.60	1.00
							6.0	0.60	0.50	1.00
							5.0	0.60	0.60	1.00
							4.0	0.59	0.50	1.00
							3.0	0.59	0.60	1.00
							2.0	0.58	0.60	1.00
							1.0	0.58	0.60	1.10
							0.0	0.58	0.60	1.20
							−1.0	0.58	0.90	1.50
							−2.0	0.58	0.40	0.60
NNW	330	1.81	6.4	2.30	63.90	10	16.0	0.74	0.70	1.30
							15.0	0.72	0.70	1.20
							12.5	0.70	0.60	1.20
							11.5	0.68	0.60	1.10
							10.0	0.67	0.60	1.10
							9.0	0.67	0.60	1.10
							8.0	0.66	0.60	1.10
							7.0	0.66	0.60	1.10
							6.0	0.65	0.60	1.10
							5.0	0.55	0.50	0.90
							4.0	0.64	0.60	1.10
							3.0	0.64	0.60	1.10
							2.0	0.63	0.60	1.10
							1.0	0.63	0.60	1.20
							0.0	0.62	0.70	1.30
							−1.0	0.62	0.90	1.50
							−2.0	0.62	0.40	0.60
N	360	1.70	6.1	2.30	58.05	10	16.0	1.14	1.10	2.00
							15.0	1.11	1.10	1.90
							12.5	1.08	1.00	1.80
							11.5	1.07	1.00	1.80
							10.0	1.05	1.00	1.70
							9.0	1.05	1.00	1.70
							8.0	1.04	1.00	1.70
							7.0	1.04	0.90	1.70
							6.0	1.03	0.90	1.70
							5.0	1.03	0.90	1.70
							4.0	1.02	0.90	1.70
							3.0	1.02	1.00	1.70
							2.0	1.01	1.00	1.80
							1.0	1.00	1.00	1.90
							0.0	0.99	1.20	2.10
							−1.0	0.99	1.20	1.70
							−2.0	0.99	0.50	0.70

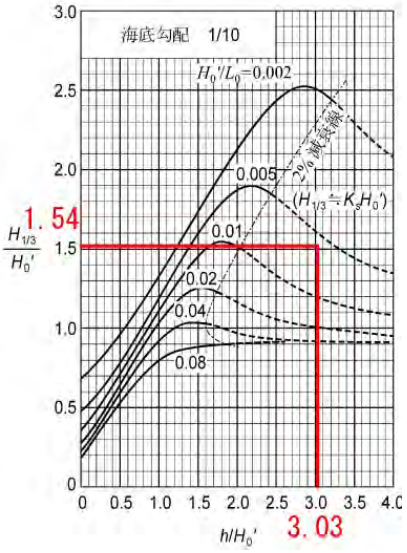
波向はNから時計まわりの角度

表 5-20　換算沖波波高，$H_{1/3}$，H_{max}一覧

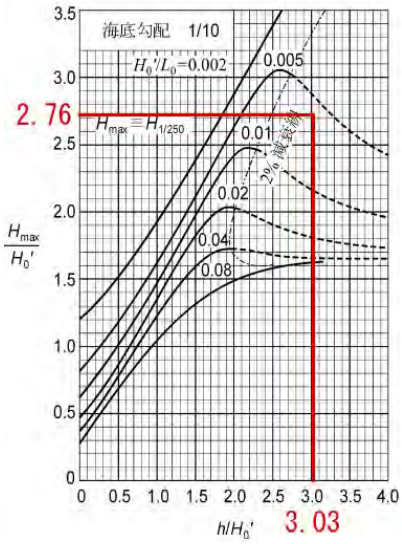
M3波向(°)		波高(m)	周期(s)	潮位(m)	Lo	勾配 (1/x x=)	水深 h(m)	Ho'(m)	H1/3(m)	Hmax(m)
NNE	22.5	0.80	3.8	2.30	22.53	10	16.0	0.80	0.80	1.40
							15.0	0.80	0.80	1.40
							12.5	0.79	0.80	1.40
							11.5	0.79	0.80	1.40
							10.0	0.78	0.80	1.40
							9.0	0.78	0.80	1.40
							8.0	0.77	0.80	1.40
							7.0	0.77	0.80	1.40
							6.0	0.76	0.70	1.30
							5.0	0.76	0.70	1.30
							4.0	0.75	0.70	1.30
							3.0	0.75	0.70	1.30
							2.0	0.74	0.70	1.20
							1.0	0.74	0.70	1.20
							0.0	0.73	0.70	1.20
							−1.0	0.73	0.80	1.30
							−2.0	0.73	0.40	0.50
NE	45	0.90	3.8	2.30	22.53	10	16.0	0.86	0.90	1.50
							15.0	0.85	0.80	1.50
							12.5	0.85	0.80	1.50
							11.5	0.84	0.80	1.50
							10.0	0.83	0.80	1.50
							9.0	0.83	0.80	1.50
							8.0	0.83	0.80	1.50
							7.0	0.82	0.80	1.40
							6.0	0.82	0.80	1.40
							5.0	0.82	0.80	1.40
							4.0	0.82	0.80	1.40
							3.0	0.81	0.80	1.40
							2.0	0.81	0.70	1.30
							1.0	0.81	0.70	1.30
							0.0	0.80	0.80	1.40
							−1.0	0.80	0.90	1.40
							−2.0	0.80	0.40	0.50
ENE	67.5	0.90	3.8	2.30	22.53	10	16.0	0.74	0.70	1.30
							15.0	0.73	0.70	1.30
							12.5	0.72	0.70	1.30
							11.5	0.72	0.70	1.30
							10.0	0.71	0.70	1.30
							9.0	0.71	0.70	1.30
							8.0	0.71	0.70	1.30
							7.0	0.71	0.70	1.30
							6.0	0.71	0.70	1.20
							5.0	0.70	0.70	1.20
							4.0	0.70	0.70	1.20
							3.0	0.70	0.60	1.20
							2.0	0.70	0.60	1.20
							1.0	0.70	0.60	1.20
							0.0	0.69	0.70	1.20
							−1.0	0.69	0.80	1.30
							−2.0	0.69	0.40	0.50

波向はNから時計まわりの角度

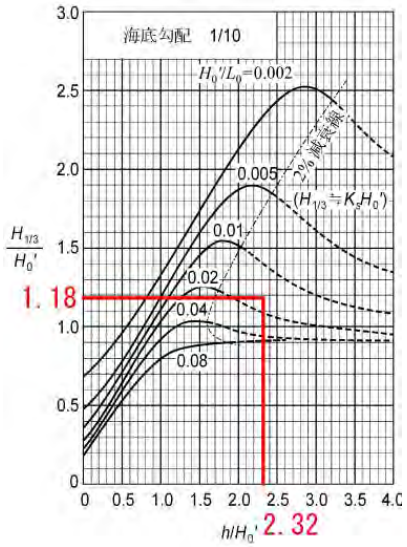
WNW



WNW



N



N

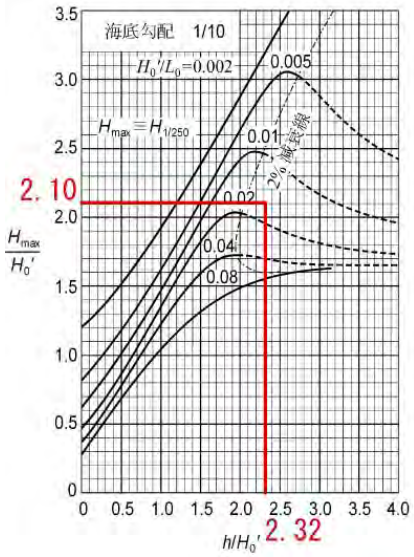
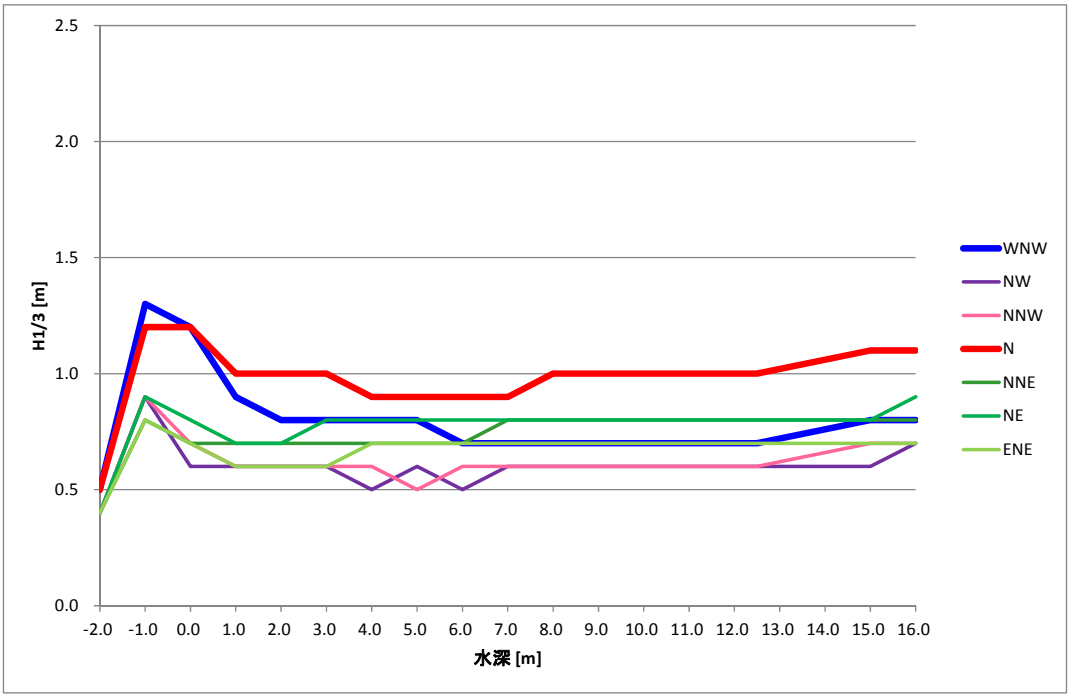


図 5-34　砕波帯内の有義波高算定図



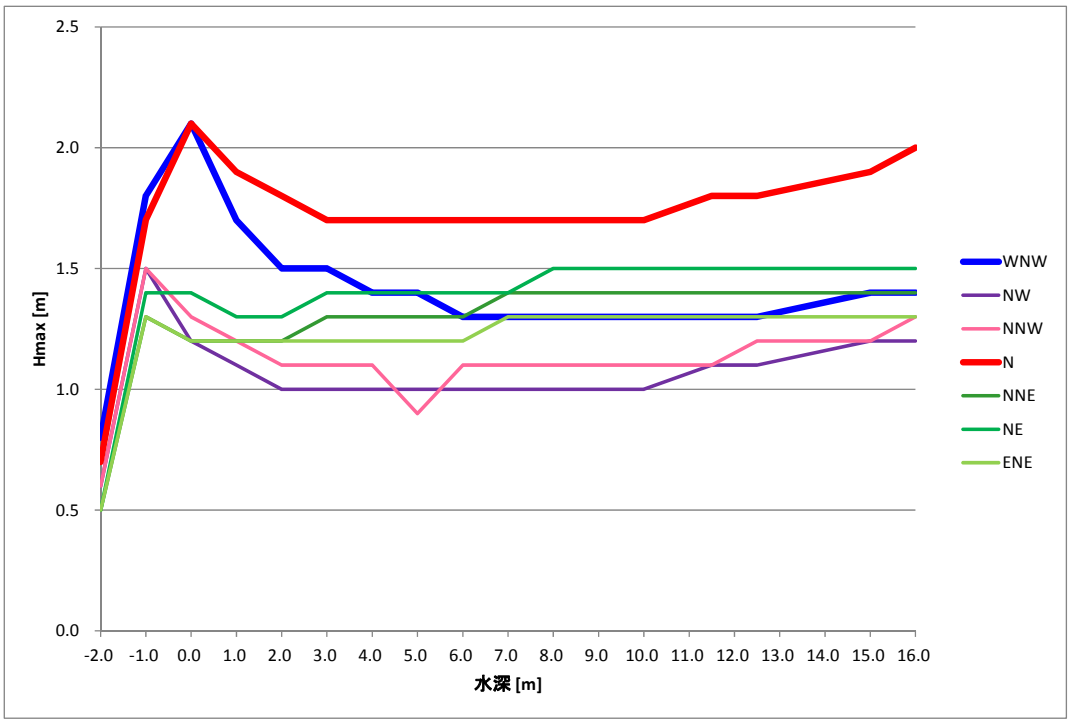


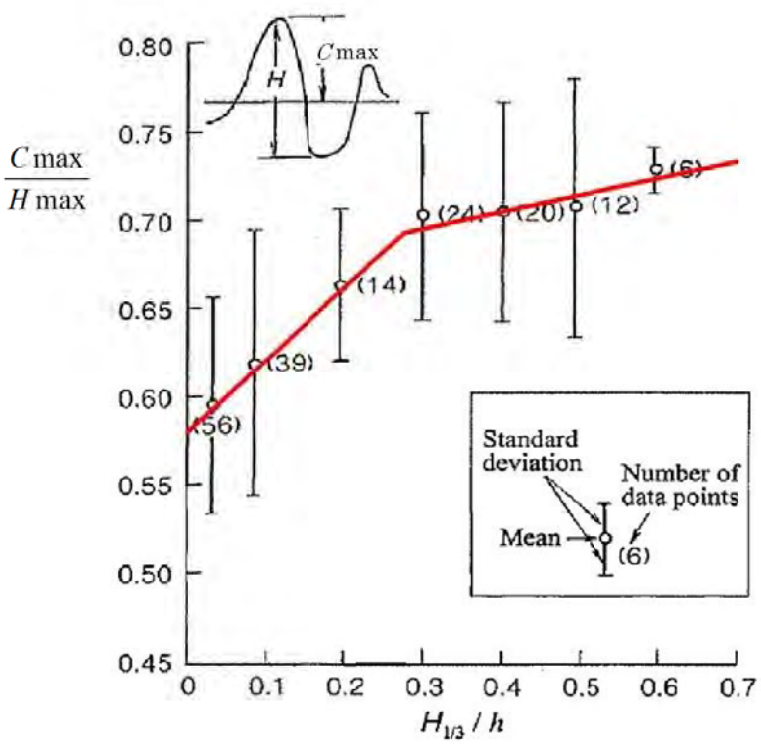
図 5-35　水深と $H_{1/3}$，H_{max} の関係（M.H.H.W 時）

水深別に波頂高（C_{max}）を算出した結果を表 5-21 に示す。C_{max}/H_{max} は図 5-36 より読み取った。表 5-21 によれば、汀線付近において約 1.5m の値が算出された。

表 5-21　水深別波頂高（50 年確率波、潮位 M.H.H.W）

M2波向	波高 (m)	周期 (s)	波向 (°)	Lo	潮位 (m)	勾配 (1/x x=)	水深 h(m)	Ho' (m)	H1/3 (m)	Hmax (m)	Cmax (m)	Ho' /Lo	h /Lo	h /Ho'	H13 /Ho'	Hmax /Ho'	H13 /h	Cmax /Hmax
N	1.36	6.1	360.0	58.05	2.30	10	16	1.14	1.08	1.94	1.16	0.020	0.315	16.05	0.95	1.80	0.06	0.60
							15	1.11	1.05	1.89	1.13	0.019	0.298	15.59	0.95	1.80	0.06	0.60
							12.5	1.08	1.00	1.80	1.10	0.019	0.255	13.70	0.93	1.80	0.07	0.61
							11.5	1.07	1.00	1.80	1.10	0.018	0.238	12.90	0.93	1.80	0.07	0.61
							10	1.05	0.97	1.75	1.07	0.018	0.212	11.71	0.92	1.80	0.08	0.61
							9.0	1.05	0.97	1.75	1.09	0.018	0.195	10.76	0.92	1.80	0.09	0.62
							8.0	1.04	0.95	1.71	1.05	0.018	0.177	9.90	0.91	1.80	0.09	0.62
							7.0	1.04	0.95	1.71	1.06	0.018	0.160	8.94	0.91	1.80	0.10	0.62
							6.0	1.03	0.94	1.69	1.05	0.018	0.143	8.06	0.91	1.80	0.11	0.62
							5.0	1.03	0.95	1.85	1.17	0.018	0.126	7.09	0.92	1.80	0.13	0.63
							4.0	1.02	0.95	1.84	1.18	0.018	0.109	6.18	0.93	1.80	0.15	0.64
							3.0	1.02	0.96	1.84	1.20	0.018	0.091	5.20	0.94	1.80	0.18	0.65
							2.0	1.01	0.97	1.82	1.22	0.017	0.074	4.26	0.96	1.80	0.23	0.67
							1.0	1.00	1.04	1.86	1.30	0.017	0.057	3.30	1.04	1.86	0.32	0.70
							0.0	0.99	1.17	2.08	1.48	0.017	0.040	2.32	1.18	2.10	0.51	0.71
WNW	1.63	9.2	324.0	132.04	2.30	10	-1.0	0.76	1.30	1.76	1.34	0.006	0.010	1.71	1.71	2.31	1.00	0.76
							-2.0	0.76	0.52	0.81	0.67	0.006	0.002	0.39	0.69	1.07	1.73	0.83

注）h/Ho'>4.0 以上は Hmax=H13*1.8としている
波向は沖から時計まわりの角度



出典：港湾構造物の耐波設計　P212

図 5-36　最高波頂高の観測

5-2-2　　静穏度検討

5-2-2-1 計算方法

静穏度の検討フローを図 5-37 に示す。

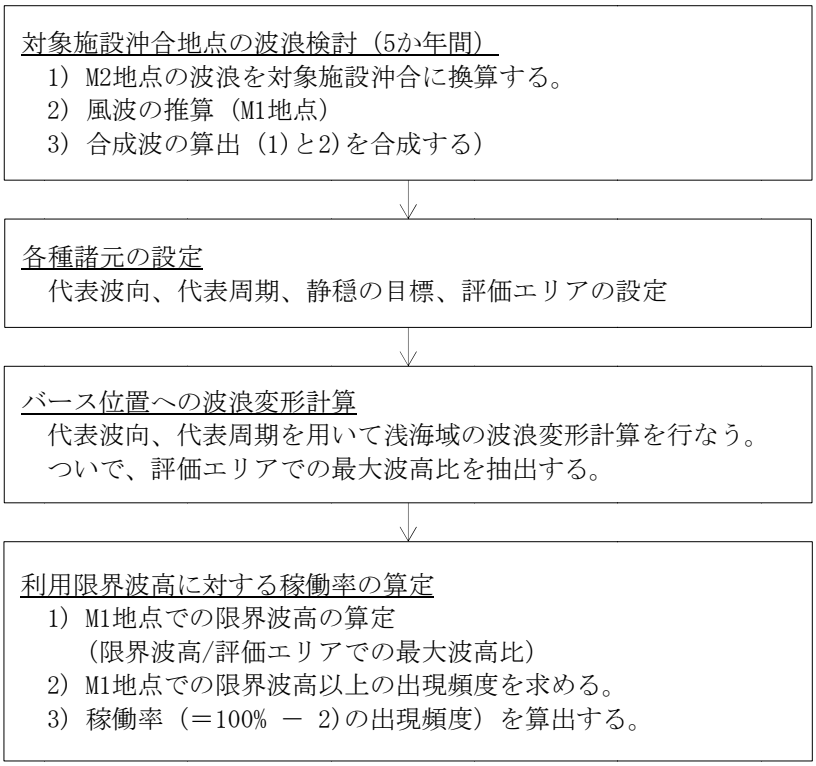


図 5-37　静穏度の検討フロー

5-2-2-2 対象施設沖合地点の波浪検討

5-2-2-2-1　　推算データを対象施設沖合に換算

図 5-20 に示す波向別換算率により M2 地点の波浪データを M1 地点の波浪にする。

(1)　手法

波浪変形計算はエネルギー平衡方程式を用いる。エネルギー平衡方程式の基礎方程式は参考資料３に示す。

(2)　条件

・波浪

5 か年間（2010 年～2014 年）

・波浪換算

換算対象波向：M1 地点の地形を考慮（前出図 5-28 参照）して WNW～N～ENE の 7 方向とした。換算沖波周期：WNW～N～ENE 方向の周期はほぼ 3.0～8.0sec であるので、4，6，8sec を設定した。

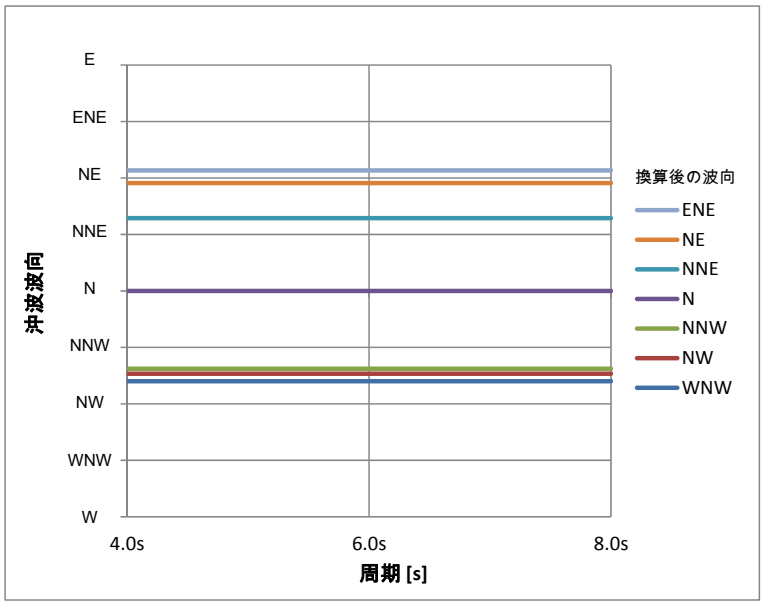
・その他

水深及び地形、潮位、計算範囲及び計算格子間隔は 5-2-1-3-2 条件に同様とする。

表 5-22　波浪換算

沖波波向	波高換算値（m）			換算後の波向（°）		
	4.0s	6.0s	8.0s	4.0s	6.0s	8.0s
WNW	0.51	0.51	0.51	324	324	324
NW	0.63	0.63	0.63	327	327	327
NNW	0.84	0.84	0.83	329	329	329
N	0.80	0.80	0.79	0	0	0
NNE	0.83	0.82	0.81	29	29	29
NE	0.82	0.81	0.80	43	43	43
ENE	0.74	0.74	0.73	48	48	48

波向はNから時計まわりの角度



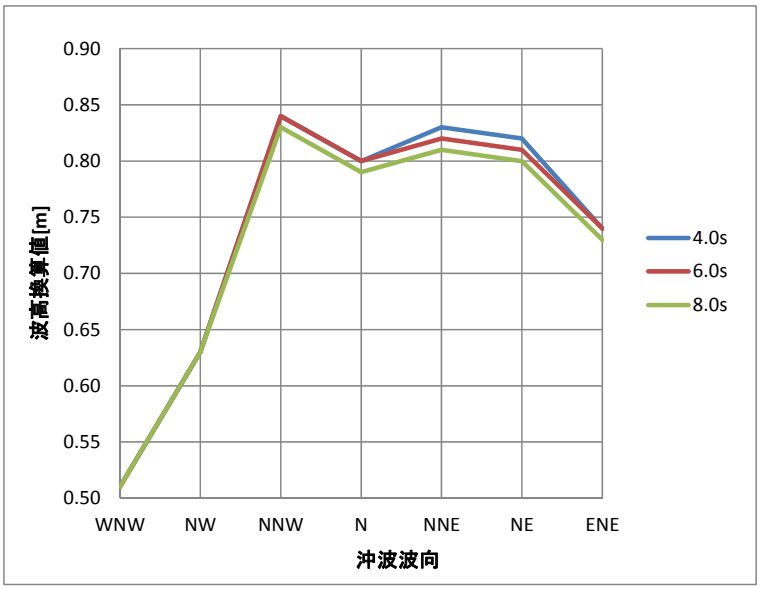


図 5-38　波浪換算

(3) 結果

表 5-3、図 5-38 は波向別、周期別に波浪変形計算を行ない、沖合から M1 地点への換算率を求めたものである。アロル島、アタウロ島の影響で開口している NNW、NNE、NE への換算率が高くなっている。この換算率をもとに、表 5-23～表 5-25 に示す M2 地点の波を M1 地点の波に変換した結果を表 5-26～表 5-28 に示す。

表 5-23　地点 M2　波高・周期頻度表

Month: 201001-201412
Point: DIL(M2wa) All months
Wave Direction: All directions

Observed	14589	(99.87)
Calm		(0.00)
Missing	19	(0.13)

Wave Period(s)	–	3.0 –	4.0 –	5.0 –	6.0 –	7.0 –	8.0 –	9.0 –	10.0 –	11.0 –	12.0 –	13.0 –	14.0 –	15.0 –	16.0 –	17.0 –	18.0 –	19.0 –	Total	Exceedance
Wave Height(m)	2.9	3.9	4.9	5.9	6.9	7.9	8.9	9.9	10.9	11.9	12.9	13.9	14.9	15.9	16.9	17.9	18.9			
– 0.24	79 (0.54)	411 (2.82)	223 (1.53)	28 (0.19)	14 (0.10)		7 (0.05)	10 (0.07)	140 (0.96)	707 (4.85)	1109 (7.60)	1129 (7.74)	928 (6.36)	411 (2.82)	225 (1.54)	172 (1.18)	22 (0.15)	49 (0.34)	5664 (38.82)	14589 (100.00)
0.25 – 0.49	857 (5.87)	844 (5.79)	712 (4.88)	126 (0.86)	19 (0.13)	6 (0.04)	1 (0.01)	6 (0.04)	2 (0.01)	25 (0.17)	123 (0.84)	316 (2.17)	448 (3.07)	236 (1.62)	146 (1.00)	95 (0.65)	20 (0.14)	30 (0.21)	4012 (27.50)	8925 (61.18)
0.50 – 0.74	118 (0.81)	2025 (13.88)	345 (2.36)	290 (1.99)	39 (0.27)	4 (0.03)	7 (0.05)				1 (0.01)	6 (0.04)	29 (0.20)	49 (0.34)	43 (0.29)	30 (0.21)	8 (0.05)	9 (0.06)	3003 (20.58)	4913 (33.68)
0.75 – 0.99	4 (0.03)	547 (3.75)	437 (3.00)	181 (1.24)	102 (0.70)		6 (0.04)				1 (0.01)				3 (0.02)				1281 (8.78)	1910 (13.09)
1.00 – 1.24		3 (0.02)	113 (0.77)	91 (0.62)	97 (0.66)	9 (0.06)	3 (0.02)												316 (2.17)	629 (4.31)
1.25 – 1.49			10 (0.07)	42 (0.29)	98 (0.67)	11 (0.08)													161 (1.10)	313 (2.15)
1.50 – 1.74				13 (0.09)	52 (0.36)	18 (0.12)													83 (0.57)	152 (1.04)
1.75 – 1.99					22 (0.15)	18 (0.12)													40 (0.27)	69 (0.47)
2.00 – 2.24					8 (0.05)	14 (0.10)													22 (0.15)	29 (0.20)
2.25 – 2.49						7 (0.05)													7 (0.05)	7 (0.05)
2.50 – 2.74																			0 (0.00)	0 (0.00)
2.75 – 2.99																			0 (0.00)	0 (0.00)
3.00 – 3.24																			0 (0.00)	0 (0.00)
3.25 – 3.49																			0 (0.00)	0 (0.00)
3.50 – 3.74																			0 (0.00)	0 (0.00)
3.75 – 3.99																			0 (0.00)	0 (0.00)
4.00 – 4.24																			0 (0.00)	0 (0.00)
4.25 – 4.49																			0 (0.00)	0 (0.00)
4.50 – 4.74																			0 (0.00)	0 (0.00)
4.75 – 4.99																			0 (0.00)	0 (0.00)
5.00 – 5.24																			0 (0.00)	0 (0.00)
5.25 – 5.49																			0 (0.00)	0 (0.00)
5.50 – 5.74																			0 (0.00)	0 (0.00)
5.75 – 5.99																			0 (0.00)	0 (0.00)
6.00 –																			0 (0.00)	0 (0.00)
Total	1058 (7.25)	3830 (26.25)	1840 (12.61)	771 (5.28)	451 (3.09)	87 (0.60)	24 (0.16)	16 (0.11)	142 (0.97)	732 (5.02)	1234 (8.46)	1451 (9.95)	1405 (9.63)	696 (4.77)	417 (2.86)	297 (2.04)	50 (0.34)	88 (0.60)	14589 (100.00)	
Exceedance	14589 (100.00)	13531 (92.75)	9701 (66.50)	7861 (53.88)	7090 (48.60)	6639 (45.51)	6552 (44.91)	6528 (44.75)	6512 (44.64)	6370 (43.66)	5638 (38.65)	4404 (30.19)	2953 (20.24)	1548 (10.61)	852 (5.84)	435 (2.98)	138 (0.95)	88 (0.60)		

表 5-24　地点 M2　波高・波向頻度表

Month: 201001-201412
Point: DL(M2ss) All months

Observed	14589	(99.87)
Calm	0	(0.00)
Missing	19	(0.13)

Wave Direction / Wave Height(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 0.24	2 (0.01)	8 (0.05)	85 (0.58)	13 (0.09)	77 (0.53)	10 (0.07)	5 (0.03)			4849 (33.24)	85 (0.58)	79 (0.54)	255 (1.75)	66 (0.45)	67 (0.46)	63 (0.43)	0 (0.00)	5664 (38.82)	14589 (100.00)
0.25 - 0.49			74 (0.51)	93 (0.64)	1130 (7.79)	135 (0.93)	3 (0.02)			1445 (9.90)	50 (0.34)	105 (0.72)	746 (5.11)	115 (0.79)	62 (0.42)	48 (0.33)		4012 (27.50)	8925 (61.18)
0.50 - 0.74			12 (0.08)	61 (0.42)	1754 (12.02)	207 (1.42)				176 (1.21)	17 (0.12)	103 (0.71)	579 (3.97)	49 (0.34)	30 (0.21)	15 (0.10)		3003 (20.58)	4913 (33.68)
0.75 - 0.99				25 (0.17)	756 (5.18)	37 (0.25)				5 (0.03)	8 (0.05)	29 (0.20)	368 (2.52)	29 (0.20)	17 (0.12)	7 (0.05)		1251 (8.78)	1910 (13.09)
1.00 - 1.24				6 (0.04)	89 (0.61)	1 (0.01)					3 (0.02)	14 (0.10)	180 (1.23)	12 (0.08)	5 (0.03)	6 (0.04)		316 (2.17)	629 (4.31)
1.25 - 1.49					11 (0.08)						8 (0.05)	13 (0.09)	115 (0.79)	4 (0.03)	2 (0.01)	8 (0.05)		161 (1.10)	313 (2.15)
1.50 - 1.74												6 (0.04)	72 (0.49)		3 (0.02)	2 (0.01)		83 (0.57)	152 (1.04)
1.75 - 1.99												2 (0.01)	38 (0.26)					40 (0.27)	69 (0.47)
2.00 - 2.24												2 (0.01)	20 (0.14)					22 (0.15)	29 (0.20)
2.25 - 2.49													7 (0.05)					7 (0.05)	7 (0.05)
2.50 - 2.74																		0 (0.00)	0 (0.00)
2.75 - 2.99																		0 (0.00)	0 (0.00)
3.00 - 3.24																		0 (0.00)	0 (0.00)
3.25 - 3.49																		0 (0.00)	0 (0.00)
3.50 - 3.74																		0 (0.00)	0 (0.00)
3.75 - 3.99																		0 (0.00)	0 (0.00)
4.00 - 4.24																		0 (0.00)	0 (0.00)
4.25 - 4.49																		0 (0.00)	0 (0.00)
4.50 - 4.74																		0 (0.00)	0 (0.00)
4.75 - 4.99																		0 (0.00)	0 (0.00)
5.00 - 5.24																		0 (0.00)	0 (0.00)
5.25 - 5.49																		0 (0.00)	0 (0.00)
5.50 - 5.74																		0 (0.00)	0 (0.00)
5.75 - 5.99																		0 (0.00)	0 (0.00)
6.00 -																		0 (0.00)	0 (0.00)
Total	2 (0.01)	8 (0.05)	171 (1.17)	198 (1.36)	3823 (26.20)	390 (2.67)	8 (0.05)	0 (0.00)	0 (0.00)	6475 (44.38)	171 (1.17)	353 (2.42)	2380 (16.31)	275 (1.88)	186 (1.27)	149 (1.02)	0 (0.00)	14589 (100.00)	
Exceedance	14589 (100.00)	14587 (99.99)	14579 (99.93)	14408 (98.76)	14210 (97.40)	10387 (71.20)	9997 (68.52)	9989 (68.47)	9989 (68.47)	3514 (24.09)	3343 (22.91)	2990 (20.49)	610 (4.18)	335 (2.30)	149 (1.02)	0 (0.00)			

表 5-25　地点 M2　周期・波向頻度表

Month: 201001-201412
Point: DIL(M2wa) All months

Observed	14589	(99.87)
Calm	0	(0.00)
Missing	19	(0.13)

Wave Direction / Wave Period(s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 2.99			2 (0.01)	66 (0.45)	822 (5.63)	74 (0.51)	2 (0.01)			8 (0.05)	24 (0.16)	17 (0.12)	26 (0.18)	4 (0.03)	11 (0.08)	2 (0.01)	0 (0.00)	1058 (7.25)	14589 (100.00)
3.00 - 3.99		6 (0.04)	18 (0.12)	114 (0.78)	2622 (17.97)	307 (2.10)	6 (0.04)			3 (0.02)	46 (0.32)	131 (0.90)	360 (2.47)	90 (0.62)	78 (0.53)	49 (0.34)		3830 (26.25)	13531 (92.75)
4.00 - 4.99	2 (0.01)	2 (0.01)	65 (0.45)	17 (0.12)	376 (2.58)	9 (0.06)					22 (0.15)	94 (0.64)	967 (6.63)	151 (1.04)	71 (0.49)	64 (0.44)		1840 (12.61)	9701 (66.50)
5.00 - 5.99			39 (0.27)		3 (0.02)						7 (0.05)	62 (0.42)	589 (4.04)	29 (0.20)	24 (0.16)	18 (0.12)		771 (5.28)	7861 (53.88)
6.00 - 6.99			39 (0.27)	1 (0.01)								26 (0.18)	366 (2.51)	1 (0.01)	2 (0.01)	16 (0.11)		451 (3.09)	7090 (48.60)
7.00 - 7.99			6 (0.04)									9 (0.06)	72 (0.49)					87 (0.60)	6639 (45.51)
8.00 - 8.99			2 (0.01)							1 (0.01)	7 (0.05)	14 (0.10)						24 (0.16)	6552 (44.91)
9.00 - 9.99										16 (0.11)								16 (0.11)	6528 (44.75)
10.00 - 10.99										128 (0.88)	14 (0.10)							142 (0.97)	6512 (44.64)
11.00 - 11.99										720 (4.94)	12 (0.08)							732 (5.02)	6370 (43.66)
12.00 - 12.99										1223 (8.38)	11 (0.08)							1234 (8.46)	5638 (38.65)
13.00 - 13.99										1444 (9.90)	7 (0.05)							1451 (9.95)	4194 (30.19)
14.00 - 14.99										1389 (9.52)	16 (0.11)							1405 (9.63)	2953 (20.24)
15.00 - 15.99										693 (4.75)	3 (0.02)							696 (4.77)	1548 (10.61)
16.00 - 16.99										417 (2.86)								417 (2.86)	852 (5.84)
17.00 - 17.99										296 (2.03)	1 (0.01)							297 (2.04)	435 (2.98)
18.00 - 18.99										49 (0.34)	1 (0.01)							50 (0.34)	138 (0.95)
19.00 -										88 (0.60)								88 (0.60)	88 (0.60)
-																			
-																			
-																			
-																			
-																			
-																			
-																			
Total	2 (0.01)	8 (0.05)	171 (1.17)	198 (1.36)	3823 (26.20)	390 (2.67)	8 (0.05)	0 (0.00)	0 (0.00)	6475 (44.38)	171 (1.17)	353 (2.42)	2380 (16.31)	275 (1.88)	186 (1.27)	149 (1.02)	0 (0.00)	14589 (100.00)	
Exceedance	14589 (100.00)	14587 (99.99)	14579 (99.93)	14408 (98.76)	14210 (97.40)	10387 (71.20)	9997 (68.52)	9989 (68.47)	9989 (68.47)	9989 (68.47)	3514 (24.09)	3343 (22.91)	2990 (20.49)	610 (4.18)	335 (2.30)	149 (1.02)	0 (0.00)		

表 5-26　地点 M1　波高・周期頻度表

Month: 201001-201412
Point: DIL(M2m1) All months
Wave Direction: All directions

Observed	14589	(99.87)
Calm	11158	(76.48)
Missing	19	(0.13)

Wave Period(s) / Wave Height(m)	— 2.9	3.0 — 3.9	4.0 — 4.9	5.0 — 5.9	6.0 — 6.9	7.0 — 7.9	8.0 — 8.9	9.0 — 9.9	10.0 — 10.9	11.0 — 11.9	12.0 — 12.9	13.0 — 13.9	14.0 — 14.9	15.0 — 15.9	16.0 — 16.9	17.0 — 17.9	18.0 — 18.9	19.0 —	Total	Exceedance
- 0.24	60 (0.41)	601 (4.12)	898 (6.16)	219 (1.50)	42 (0.29)	6 (0.04)	14 (0.10)												1840 (12.61)	3431 (23.52)
0.25 - 0.49	5 (0.03)	68 (0.47)	456 (3.13)	390 (2.67)	215 (1.47)	25 (0.17)	1 (0.01)												1160 (7.95)	1591 (10.91)
0.50 - 0.74		2 (0.01)	43 (0.29)	117 (0.80)	137 (0.94)	33 (0.23)	1 (0.01)												333 (2.28)	431 (2.95)
0.75 - 0.99			1 (0.01)	16 (0.11)	40 (0.27)	16 (0.11)													73 (0.50)	98 (0.67)
1.00 - 1.24				3 (0.02)	10 (0.07)	7 (0.05)													20 (0.14)	25 (0.17)
1.25 - 1.49				1 (0.01)	4 (0.03)														5 (0.03)	5 (0.03)
1.50 - 1.74																			0 (0.00)	0 (0.00)
1.75 - 1.99																			0 (0.00)	0 (0.00)
2.00 - 2.24																			0 (0.00)	0 (0.00)
2.25 - 2.49																			0 (0.00)	0 (0.00)
2.50 - 2.74																			0 (0.00)	0 (0.00)
2.75 - 2.99																			0 (0.00)	0 (0.00)
3.00 - 3.24																			0 (0.00)	0 (0.00)
3.25 - 3.49																			0 (0.00)	0 (0.00)
3.50 - 3.74																			0 (0.00)	0 (0.00)
3.75 - 3.99																			0 (0.00)	0 (0.00)
4.00 - 4.24																			0 (0.00)	0 (0.00)
4.25 - 4.49																			0 (0.00)	0 (0.00)
4.50 - 4.74																			0 (0.00)	0 (0.00)
4.75 - 4.99																			0 (0.00)	0 (0.00)
5.00 - 5.24																			0 (0.00)	0 (0.00)
5.25 - 5.49																			0 (0.00)	0 (0.00)
5.50 - 5.74																			0 (0.00)	0 (0.00)
5.75 - 5.99																			0 (0.00)	0 (0.00)
6.00 -																			0 (0.00)	0 (0.00)
Total	65 (0.45)	671 (4.60)	1398 (9.58)	746 (5.11)	448 (3.07)	87 (0.60)	16 (0.11)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	3431 (23.52)	
Exceedance	3431 (23.52)	3366 (23.07)	2695 (18.47)	1297 (8.89)	551 (3.78)	103 (0.71)	16 (0.11)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)		

表 5-27　地点 M1　波高・波向頻度表

Month : 201001-201412
Point : DL(032m1) All months

Observed	14589	(99.87)
Calm	11158	(76.48)
Missing	19	(0.13)

Wave Direction / Wave Height(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 0.24	2 (0.01)	112 (0.77)	31 (0.21)	16 (0.11)								211 (1.45)	1069 (7.33)	238 (1.63)	86 (0.59)	75 (0.51)	11158 (76.48)	12998 (89.09)	14589 (100.00)
0.25 - 0.49		47 (0.32)	1 (0.01)									19 (0.13)	876 (6.00)	153 (1.05)	50 (0.34)	14 (0.10)		1160 (7.95)	1391 (10.91)
0.50 - 0.74		1 (0.01)										2 (0.01)	232 (1.59)	57 (0.39)	33 (0.23)	8 (0.05)		333 (2.28)	431 (2.95)
0.75 - 0.99													50 (0.34)	7 (0.05)	12 (0.08)	4 (0.03)		73 (0.50)	98 (0.67)
1.00 - 1.24													8 (0.05)		7 (0.05)	5 (0.03)		20 (0.14)	25 (0.17)
1.25 - 1.49															5 (0.03)			5 (0.03)	5 (0.03)
1.50 - 1.74																		0 (0.00)	0 (0.00)
1.75 - 1.99																		0 (0.00)	0 (0.00)
2.00 - 2.24																		0 (0.00)	0 (0.00)
2.25 - 2.49																		0 (0.00)	0 (0.00)
2.50 - 2.74																		0 (0.00)	0 (0.00)
2.75 - 2.99																		0 (0.00)	0 (0.00)
3.00 - 3.24																		0 (0.00)	0 (0.00)
3.25 - 3.49																		0 (0.00)	0 (0.00)
3.50 - 3.74																		0 (0.00)	0 (0.00)
3.75 - 3.99																		0 (0.00)	0 (0.00)
4.00 - 4.24																		0 (0.00)	0 (0.00)
4.25 - 4.49																		0 (0.00)	0 (0.00)
4.50 - 4.74																		0 (0.00)	0 (0.00)
4.75 - 4.99																		0 (0.00)	0 (0.00)
5.00 - 5.24																		0 (0.00)	0 (0.00)
5.25 - 5.49																		0 (0.00)	0 (0.00)
5.50 - 5.74																		0 (0.00)	0 (0.00)
5.75 - 5.99																		0 (0.00)	0 (0.00)
6.00 -																		0 (0.00)	0 (0.00)
Total	2 (0.01)	160 (1.10)	32 (0.22)	16 (0.11)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	232 (1.59)	2235 (15.32)	455 (3.12)	193 (1.32)	106 (0.73)	11158 (76.48)	14589 (100.00)	
Exceedance	14589 (100.00)	14587 (99.99)	14427 (98.89)	14395 (98.67)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14147 (96.97)	11912 (81.65)	11457 (78.53)	11264 (77.21)	11158 (76.48)		

表 5-28　地点 M1　周期・波向頻度表

Month: 201001-201412
Point: DIL(M2m1) All months

Observed	14589	(99.87)
Calm	11158	(76.48)
Missing	19	(0.13)

Wave Direction / Wave Period(s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 2.99			9 (0.06)	4 (0.03)								9 (0.06)	25 (0.17)	9 (0.06)	7 (0.05)	2 (0.01)	11158 (76.48)	11223 (76.93)	14589 (100.00)
3.00 - 3.99	1 (0.01)	20 (0.14)	8 (0.05)	8 (0.05)								58 (0.40)	318 (2.18)	149 (1.02)	73 (0.50)	36 (0.25)		671 (4.60)	3366 (23.07)
4.00 - 4.99	1 (0.01)	62 (0.42)	7 (0.05)	4 (0.03)								71 (0.49)	899 (6.16)	233 (1.60)	74 (0.51)	47 (0.32)		1398 (9.58)	2695 (18.47)
5.00 - 5.99		35 (0.24)	4 (0.03)									47 (0.32)	563 (3.86)	55 (0.38)	31 (0.21)	11 (0.08)		746 (5.11)	1297 (8.89)
6.00 - 6.99		35 (0.24)	4 (0.03)									24 (0.16)	358 (2.45)	9 (0.06)	8 (0.05)	10 (0.07)		448 (3.07)	551 (3.78)
7.00 - 7.99		6 (0.04)										9 (0.06)	72 (0.49)					87 (0.60)	103 (0.71)
8.00 - 8.99		2 (0.01)										14 (0.10)						16 (0.11)	16 (0.11)
9.00 - 9.99																		0 (0.00)	0 (0.00)
10.00 - 10.99																		0 (0.00)	0 (0.00)
11.00 - 11.99																		0 (0.00)	0 (0.00)
12.00 - 12.99																		0 (0.00)	0 (0.00)
13.00 - 13.99																		0 (0.00)	0 (0.00)
14.00 - 14.99																		0 (0.00)	0 (0.00)
15.00 - 15.99																		0 (0.00)	0 (0.00)
16.00 - 16.99																		0 (0.00)	0 (0.00)
17.00 - 17.99																		0 (0.00)	0 (0.00)
18.00 - 18.99																		0 (0.00)	0 (0.00)
19.00 -																		0 (0.00)	0 (0.00)
-																			
-																			
-																			
-																			
-																			
-																			
-																			
-																			
Total	2 (0.01)	160 (1.10)	32 (0.22)	16 (0.11)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	232 (1.59)	2235 (15.32)	455 (3.12)	193 (1.32)	106 (0.73)	11158 (76.48)	14589 (100.00)	
Exceedance	14589 (100.00)	14587 (99.99)	14427 (98.89)	14395 (98.67)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14379 (98.56)	14147 (96.97)	11912 (81.65)	11457 (78.53)	11264 (77.21)	11158 (76.48)		

5-2-2-2-2　　風波の推算

(1)　手法

SMB 法により算出した。

(2)　条件

・風

M3 地点における 5 か年間（2010 年～2014 年）の風を使用した。

・有効吹送距離

有効吹送距離は、図 5-16 に示す値を使用した。なお、推算にあたっては、設計波算出の時と同様に NNE～ENE 方向を対象とした。

(3)　結果

推算結果を表 5-29～表 5-31 に示す。

表 5-29　波高・周期頻度表

Month: 201001-201412
Point: DLI(PI) All months
Wave Direction: All directions

Observed	14608	(100.00)
Calm	7891	(54.02)
Missing		(0.00)

Wave Period(s) / Wave Height(m)	– 2.9	3.0 – 3.9	4.0 – 4.9	5.0 – 5.9	6.0 – 6.9	7.0 – 7.9	8.0 – 8.9	9.0 – 9.9	10.0 – 10.9	11.0 – 11.9	12.0 – 12.9	13.0 – 13.9	14.0 – 14.9	15.0 – 15.9	16.0 – 16.9	17.0 – 17.9	18.0 – 18.9	19.0 –	Total	Exceedance
– 0.24	5353 (36.64)	161 (1.10)																	5514 (37.75)	6717 (45.98)
0.25 – 0.49	1163 (7.96)	29 (0.20)																	1192 (8.16)	1203 (8.24)
0.50 – 0.74	8 (0.05)	3 (0.02)																	11 (0.08)	11 (0.08)
0.75 – 0.99																			0 (0.00)	0 (0.00)
1.00 – 1.24																			0 (0.00)	0 (0.00)
1.25 – 1.49																			0 (0.00)	0 (0.00)
1.50 – 1.74																			0 (0.00)	0 (0.00)
1.75 – 1.99																			0 (0.00)	0 (0.00)
2.00 – 2.24																			0 (0.00)	0 (0.00)
2.25 – 2.49																			0 (0.00)	0 (0.00)
2.50 – 2.74																			0 (0.00)	0 (0.00)
2.75 – 2.99																			0 (0.00)	0 (0.00)
3.00 – 3.24																			0 (0.00)	0 (0.00)
3.25 – 3.49																			0 (0.00)	0 (0.00)
3.50 – 3.74																			0 (0.00)	0 (0.00)
3.75 – 3.99																			0 (0.00)	0 (0.00)
4.00 – 4.24																			0 (0.00)	0 (0.00)
4.25 – 4.49																			0 (0.00)	0 (0.00)
4.50 – 4.74																			0 (0.00)	0 (0.00)
4.75 – 4.99																			0 (0.00)	0 (0.00)
5.00 – 5.24																			0 (0.00)	0 (0.00)
5.25 – 5.49																			0 (0.00)	0 (0.00)
5.50 – 5.74																			0 (0.00)	0 (0.00)
5.75 – 5.99																			0 (0.00)	0 (0.00)
6.00 –																			0 (0.00)	0 (0.00)
Total	6524 (44.66)	193 (1.32)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	6717 (45.98)	
Exceedance	6717 (45.98)	193 (1.32)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)		

表 5-30　波高・波向頻度表

Month: 201001-201412
Point: DIL(P1) All months

Observed	14608	(100.00)
Calm	7891	(54.02)
Missing	0	(0.00)

Wave Direction / Wave Height(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 0.24	1667 (11.41)	715 (4.89)	3132 (21.44)														7891 (54.02)	13405 (91.76)	14608 (100.00)
0.25 - 0.49	213 (1.46)	135 (0.92)	844 (5.78)															1192 (8.16)	1203 (8.24)
0.50 - 0.74	1 (0.01)		10 (0.07)															11 (0.08)	11 (0.08)
0.75 - 0.99																		0 (0.00)	0 (0.00)
1.00 - 1.24																		0 (0.00)	0 (0.00)
1.25 - 1.49																		0 (0.00)	0 (0.00)
1.50 - 1.74																		0 (0.00)	0 (0.00)
1.75 - 1.99																		0 (0.00)	0 (0.00)
2.00 - 2.24																		0 (0.00)	0 (0.00)
2.25 - 2.49																		0 (0.00)	0 (0.00)
2.50 - 2.74																		0 (0.00)	0 (0.00)
2.75 - 2.99																		0 (0.00)	0 (0.00)
3.00 - 3.24																		0 (0.00)	0 (0.00)
3.25 - 3.49																		0 (0.00)	0 (0.00)
3.50 - 3.74																		0 (0.00)	0 (0.00)
3.75 - 3.99																		0 (0.00)	0 (0.00)
4.00 - 4.24																		0 (0.00)	0 (0.00)
4.25 - 4.49																		0 (0.00)	0 (0.00)
4.50 - 4.74																		0 (0.00)	0 (0.00)
4.75 - 4.99																		0 (0.00)	0 (0.00)
5.00 - 5.24																		0 (0.00)	0 (0.00)
5.25 - 5.49																		0 (0.00)	0 (0.00)
5.50 - 5.74																		0 (0.00)	0 (0.00)
5.75 - 5.99																		0 (0.00)	0 (0.00)
6.00 -																		0 (0.00)	0 (0.00)
Total	1881 (12.88)	850 (5.82)	3986 (27.29)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	7891 (54.02)	14608 (100.00)	

表 5-31　周期・波向頻度表

Month: 201001-201412
Point : DIL(P1) All months

Observed	14608	(100.00)
Calm	7891	(54.02)
Missing	0	(0.00)

Wave Direction / Wave Period(s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 2.99	1784 (12.21)	807 (5.52)	3933 (26.92)														7891 (54.02)	14415 (98.68)	14608 (100.00)
3.00 - 3.99	97 (0.66)	43 (0.29)	53 (0.36)															193 (1.32)	193 (1.32)
4.00 - 4.99																		0 (0.00)	0 (0.00)
5.00 - 5.99																		0 (0.00)	0 (0.00)
6.00 - 6.99																		0 (0.00)	0 (0.00)
7.00 - 7.99																		0 (0.00)	0 (0.00)
8.00 - 8.99																		0 (0.00)	0 (0.00)
9.00 - 9.99																		0 (0.00)	0 (0.00)
10.00 - 10.99																		0 (0.00)	0 (0.00)
11.00 - 11.99																		0 (0.00)	0 (0.00)
12.00 - 12.99																		0 (0.00)	0 (0.00)
13.00 - 13.99																		0 (0.00)	0 (0.00)
14.00 - 14.99																		0 (0.00)	0 (0.00)
15.00 - 15.99																		0 (0.00)	0 (0.00)
16.00 - 16.99																		0 (0.00)	0 (0.00)
17.00 - 17.99																		0 (0.00)	0 (0.00)
18.00 - 18.99																		0 (0.00)	0 (0.00)
19.00 -																		0 (0.00)	0 (0.00)
-																			
-																			
-																			
-																			
-																			
-																			
-																			
Total	1881 (12.88)	850 (5.82)	3986 (27.29)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	7891 (54.02)	14608 (100.00)	
Exceedance	14608 (100.00)	12727 (87.12)	11877 (81.30)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)	7891 (54.02)		

5-2-2-2-3　　合成波算出

ここでは､前項で算出したM1地点での換算波浪とSMB法にて推算した波浪結果を合成した。合成にあたっては、換算波浪と SMB 法による推算波を比較して波高の大きい値を採用した。合成した結果を表 5-32～表 5-34 に示す。

表 5-32　波高・周期頻度表

Month: 201001-201412
Point: DILI(qM2P) All months
Wave Direction: All directions

Observed	14592	(99.89)
Calm	4870	(33.37)
Missing	16	(0.11)

Wave Period(s) / Wave Height(m)	– 2.9	3.0 – 3.9	4.0 – 4.9	5.0 – 5.9	6.0 – 6.9	7.0 – 7.9	8.0 – 8.9	9.0 – 9.9	10.0 – 10.9	11.0 – 11.9	12.0 – 12.9	13.0 – 13.9	14.0 – 14.9	15.0 – 15.9	16.0 – 16.9	17.0 – 17.9	18.0 – 18.9	19.0 –	Total	Exceedance
– 0.24	5182 (35.51)	707 (4.85)	803 (5.50)	192 (1.32)	40 (0.27)	6 (0.04)	14 (0.10)												6944 (47.59)	9722 (66.63)
0.25 – 0.49	1157 (7.93)	96 (0.66)	453 (3.10)	389 (2.67)	215 (1.47)	25 (0.17)	1 (0.01)												2336 (16.01)	2778 (19.04)
0.50 – 0.74	8 (0.05)	5 (0.03)	43 (0.29)	117 (0.80)	137 (0.94)	33 (0.23)	1 (0.01)												344 (2.36)	442 (3.03)
0.75 – 0.99			1 (0.01)	16 (0.11)	40 (0.27)	16 (0.11)													73 (0.50)	98 (0.67)
1.00 – 1.24				3 (0.02)	10 (0.07)	7 (0.05)													20 (0.14)	25 (0.17)
1.25 – 1.49				1 (0.01)	4 (0.03)														5 (0.03)	5 (0.03)
1.50 – 1.74																			0 (0.00)	0 (0.00)
1.75 – 1.99																			0 (0.00)	0 (0.00)
2.00 – 2.24																			0 (0.00)	0 (0.00)
2.25 – 2.49																			0 (0.00)	0 (0.00)
2.50 – 2.74																			0 (0.00)	0 (0.00)
2.75 – 2.99																			0 (0.00)	0 (0.00)
3.00 – 3.24																			0 (0.00)	0 (0.00)
3.25 – 3.49																			0 (0.00)	0 (0.00)
3.50 – 3.74																			0 (0.00)	0 (0.00)
3.75 – 3.99																			0 (0.00)	0 (0.00)
4.00 – 4.24																			0 (0.00)	0 (0.00)
4.25 – 4.49																			0 (0.00)	0 (0.00)
4.50 – 4.74																			0 (0.00)	0 (0.00)
4.75 – 4.99																			0 (0.00)	0 (0.00)
5.00 – 5.24																			0 (0.00)	0 (0.00)
5.25 – 5.49																			0 (0.00)	0 (0.00)
5.50 – 5.74																			0 (0.00)	0 (0.00)
5.75 – 5.99																			0 (0.00)	0 (0.00)
6.00 –																			0 (0.00)	0 (0.00)
Total	6347 (43.50)	808 (5.54)	1300 (8.91)	718 (4.92)	446 (3.06)	87 (0.60)	16 (0.11)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	9722 (66.63)	
Exceedance	9722 (66.63)	3375 (23.13)	2567 (17.59)	1267 (8.68)	549 (3.76)	103 (0.71)	16 (0.11)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)		

表 5-33　波高・波向頻度表

Month: 201001-201412
Point: DiLI(caM2P) All months

Observed	14592 (99.89)
Calm	4870 (33.37)
Missing	16 (0.11)

Wave Direction / Wave Height(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
– 0.24	1527 (10.46)	761 (5.22)	3089 (21.17)	1 (0.01)								203 (1.39)	980 (6.72)	228 (1.56)	82 (0.56)	73 (0.50)	4870 (33.37)	11814 (80.96)	14592 (100.00)
0.25 – 0.49	211 (1.45)	176 (1.21)	837 (5.74)									19 (0.13)	876 (6.00)	153 (1.05)	50 (0.34)	14 (0.10)		2336 (16.01)	2778 (19.04)
0.50 – 0.74	1 (0.01)	1 (0.01)	10 (0.07)									2 (0.01)	232 (1.59)	57 (0.39)	33 (0.23)	8 (0.05)		344 (2.36)	442 (3.03)
0.75 – 0.99													50 (0.34)	7 (0.05)	12 (0.08)	4 (0.03)		73 (0.50)	98 (0.67)
1.00 – 1.24													8 (0.05)		7 (0.05)	5 (0.03)		20 (0.14)	25 (0.17)
1.25 – 1.49															5 (0.03)			5 (0.03)	5 (0.03)
1.50 – 1.74																		0 (0.00)	0 (0.00)
1.75 – 1.99																		0 (0.00)	0 (0.00)
2.00 – 2.24																		0 (0.00)	0 (0.00)
2.25 – 2.49																		0 (0.00)	0 (0.00)
2.50 – 2.74																		0 (0.00)	0 (0.00)
2.75 – 2.99																		0 (0.00)	0 (0.00)
3.00 – 3.24																		0 (0.00)	0 (0.00)
3.25 – 3.49																		0 (0.00)	0 (0.00)
3.50 – 3.74																		0 (0.00)	0 (0.00)
3.75 – 3.99																		0 (0.00)	0 (0.00)
4.00 – 4.24																		0 (0.00)	0 (0.00)
4.25 – 4.49																		0 (0.00)	0 (0.00)
4.50 – 4.74																		0 (0.00)	0 (0.00)
4.75 – 4.99																		0 (0.00)	0 (0.00)
5.00 – 5.24																		0 (0.00)	0 (0.00)
5.25 – 5.49																		0 (0.00)	0 (0.00)
5.50 – 5.74																		0 (0.00)	0 (0.00)
5.75 – 5.99																		0 (0.00)	0 (0.00)
6.00 –																		0 (0.00)	0 (0.00)
Total	1739 (11.92)	938 (6.43)	3936 (26.97)	1 (0.01)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	224 (1.54)	2146 (14.71)	445 (3.05)	189 (1.30)	104 (0.71)	4870 (33.37)	14592 (100.00)	

表 5-34　周期・波向頻度表

Month : 201001-201412
Point : DIJ(qM2P) All months

Observed	14592	(99.89)
Calm	4870	(33.37)
Missing	16	(0.11)

Wave Direction / Wave Period(s)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CAM	Total	Exceedance
- 2.99	1645 (11.27)	776 (5.32)	3875 (26.56)	1 (0.01)								9 (0.06)	24 (0.16)	9 (0.06)	6 (0.04)	2 (0.01)	4870 (33.37)	11217 (76.87)	14592 (100.00)
3.00 - 3.99	93 (0.64)	54 (0.37)	55 (0.38)									57 (0.39)	300 (2.06)	144 (0.99)	71 (0.49)	34 (0.23)		808 (5.54)	3375 (23.13)
4.00 - 4.99	1 (0.01)	37 (0.25)	2 (0.01)									68 (0.47)	841 (5.76)	231 (1.58)	73 (0.50)	47 (0.32)		1300 (8.91)	2567 (17.59)
5.00 - 5.99		30 (0.21)										43 (0.29)	551 (3.78)	52 (0.36)	31 (0.21)	11 (0.08)		718 (4.92)	1267 (8.68)
6.00 - 6.99		33 (0.23)	4 (0.03)									24 (0.16)	358 (2.45)	9 (0.06)	8 (0.05)	10 (0.07)		446 (3.06)	549 (3.76)
7.00 - 7.99		6 (0.04)										9 (0.06)	72 (0.49)					87 (0.60)	103 (0.71)
8.00 - 8.99		2 (0.01)										14 (0.10)						16 (0.11)	16 (0.11)
9.00 - 9.99																		0 (0.00)	0 (0.00)
10.00 - 10.99																		0 (0.00)	0 (0.00)
11.00 - 11.99																		0 (0.00)	0 (0.00)
12.00 - 12.99																		0 (0.00)	0 (0.00)
13.00 - 13.99																		0 (0.00)	0 (0.00)
14.00 - 14.99																		0 (0.00)	0 (0.00)
15.00 - 15.99																		0 (0.00)	0 (0.00)
16.00 - 16.99																		0 (0.00)	0 (0.00)
17.00 - 17.99																		0 (0.00)	0 (0.00)
18.00 - 18.99																		0 (0.00)	0 (0.00)
19.00 -																		0 (0.00)	0 (0.00)
-																			
-																			
-																			
-																			
-																			
-																			
-																			
Total	1739 (11.92)	938 (6.43)	3936 (26.97)	1 (0.01)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	224 (1.54)	2146 (14.71)	445 (3.05)	189 (1.30)	104 (0.71)	4870 (33.37)	14592 (100.00)	
Exceedance	14592 (100.00)	12853 (88.08)	11915 (81.65)	7979 (54.68)	7978 (54.67)	7978 (54.67)	7978 (54.67)	7978 (54.67)	7978 (54.67)	7978 (54.67)	7978 (54.67)	7978 (54.67)	7754 (53.14)	5608 (38.43)	5163 (35.38)	4974 (34.09)	4870 (33.37)		

5-2-2-3 各種諸元の設定

稼働率算出にあたって必要な諸元を設定した。

5-2-2-3-1 代表波向

対象地点の地形及び合成波の波向を考慮して代表波向を図 5-40 に示す NW、NNW、N、NNE、NE とした。

5-2-2-3-2 代表周期

合成波高・周期の頻度表によれば卓越する周期帯は 5.0～7.0sec であるので、ここでは代表周期を 6.0sec とした。

5-2-2-3-3 静穏の目標

表 5-35 は、荷役限界波高の参考値である。この表より荷役限界波高（$H_{1/3}$）を 0.3m、0.5m の 2 種とした。

表 5-35　荷役限界波高の参考値

船形	荷役限界波高（H1/3）
小型船	0.3m
中・大型船	0.5m
超大型船	0.7～1.5m

※うねり性の波浪及び長周期波による影響が無い場合

出典：港湾の施設の技術上の基準・同解説（平成 19 年 7 月）p.809

5-2-2-3-4 稼働率評価エリア

評価点は、図 5-39 に示す桟橋の西側（A）と東側（B）を設定した。

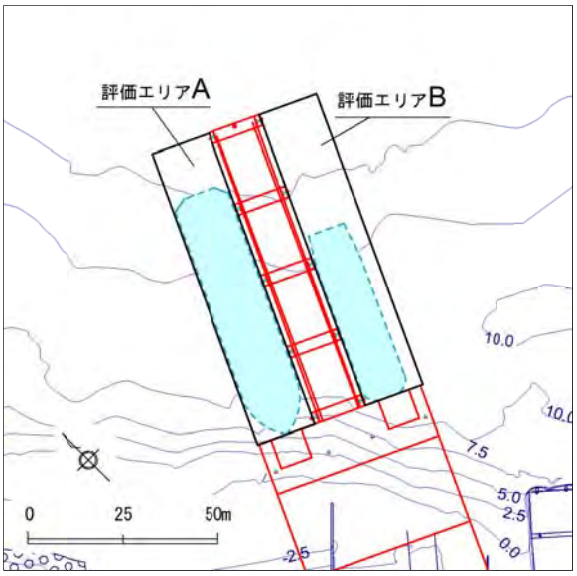


図 5-39　稼働率評価エリア

5-2-2-4 バース位置への波浪変形計算

5-2-2-4-1　　バース位置までの波浪変形計算

代表波向、代表周期を用いて浅海域の波浪変形計算を行なった。

(1)　手法

解析手法は、エネルギー平衡方程式により算出した。

(2)　条件

・波浪

代表波向：NW、NNW、N、NNE、NE
代表周期：6.0sec

・計算範囲及び計算格子間隔

計算格子間隔 10m

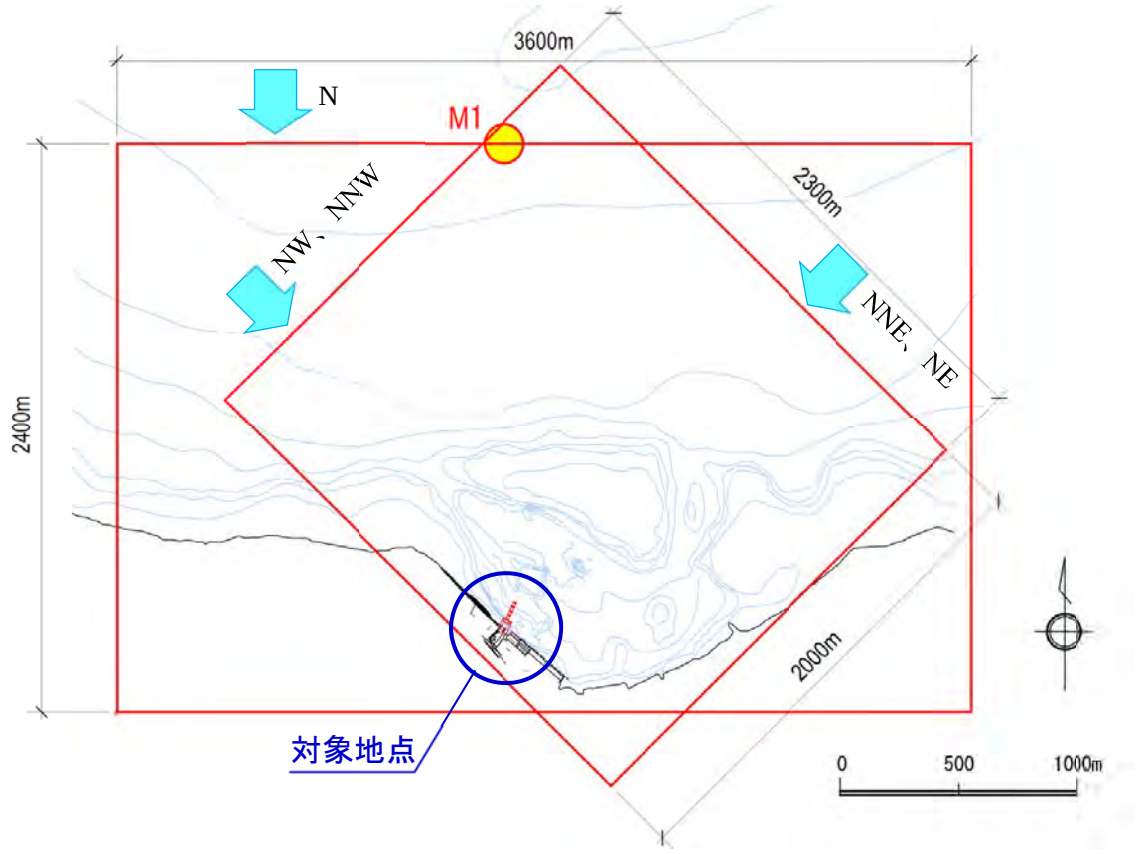


図 5-40　計算範囲

(3)　結果

計算結果を図 5-41 から図 5-45 に示す。

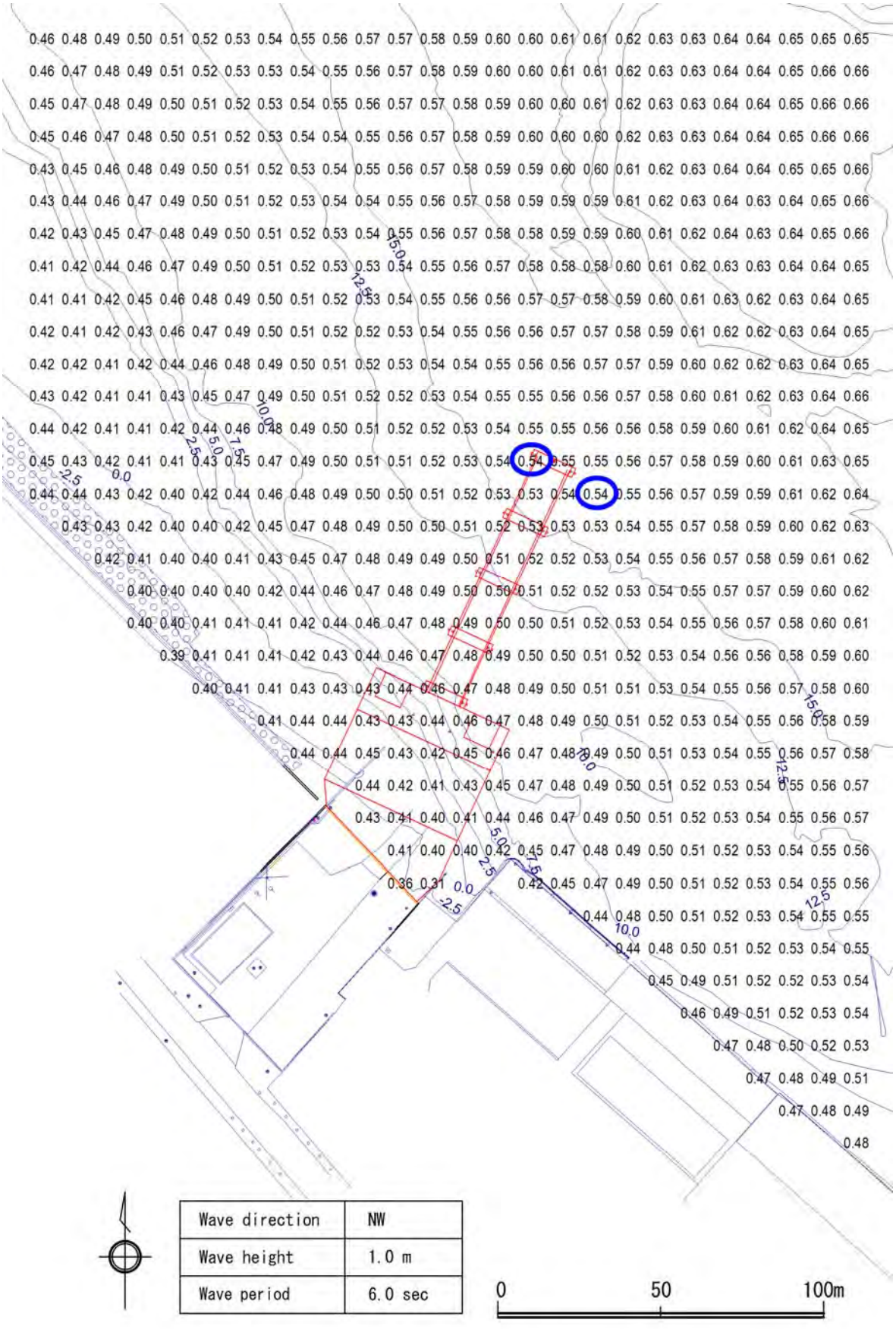


図 5-41　波高比分布（NW）

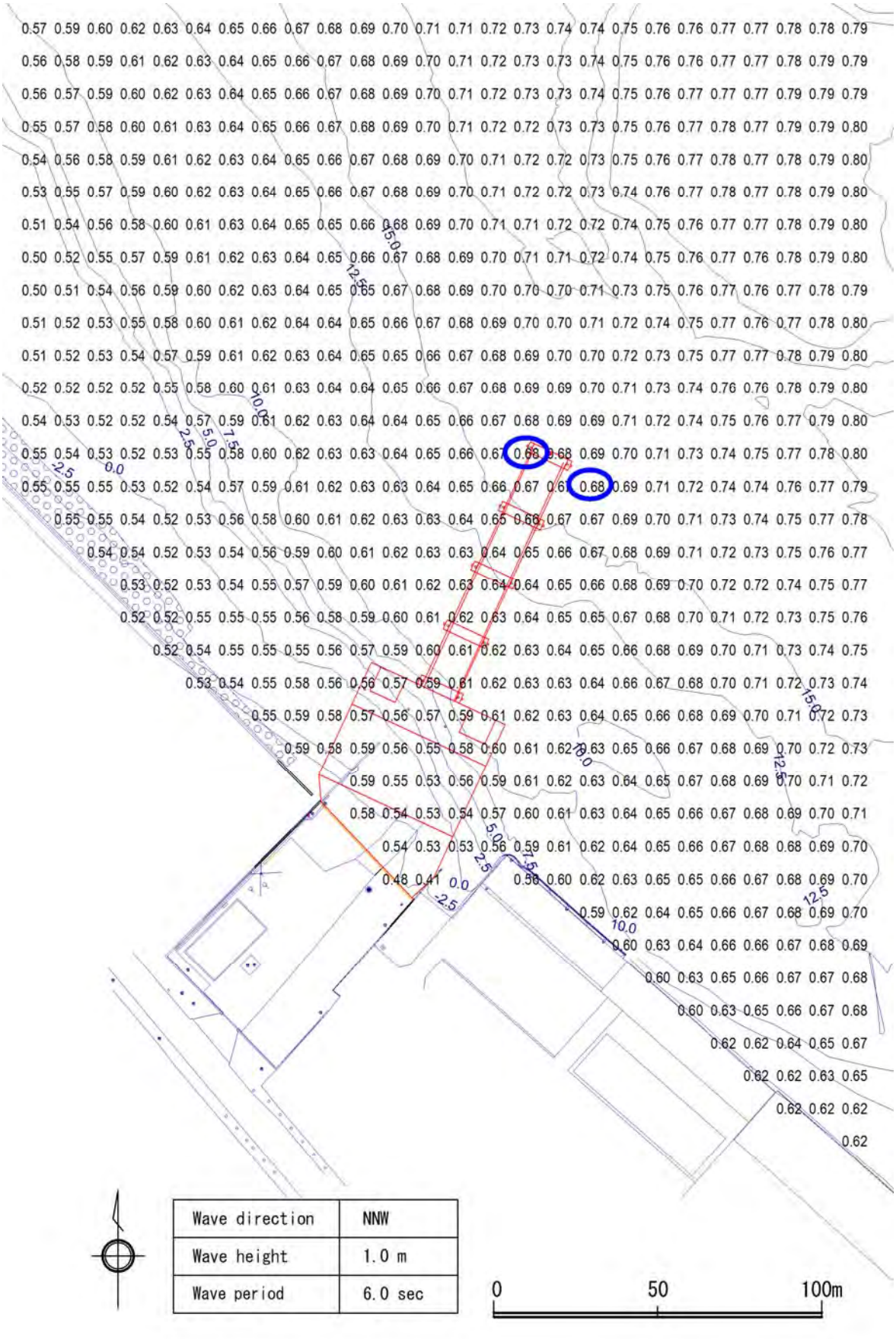


図 5-42　波高比分布（NNW）

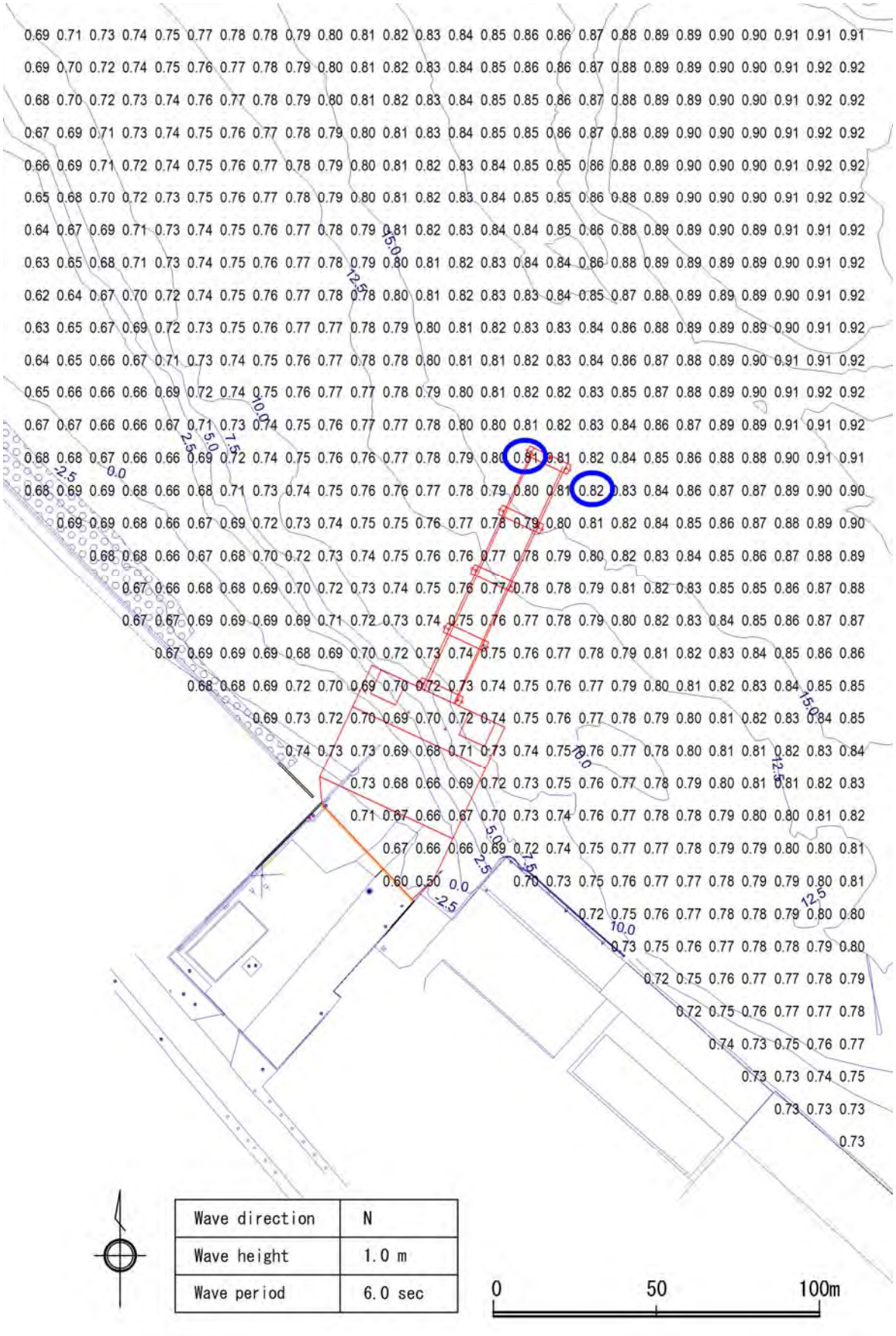


図 5-43　波高比分布（N）

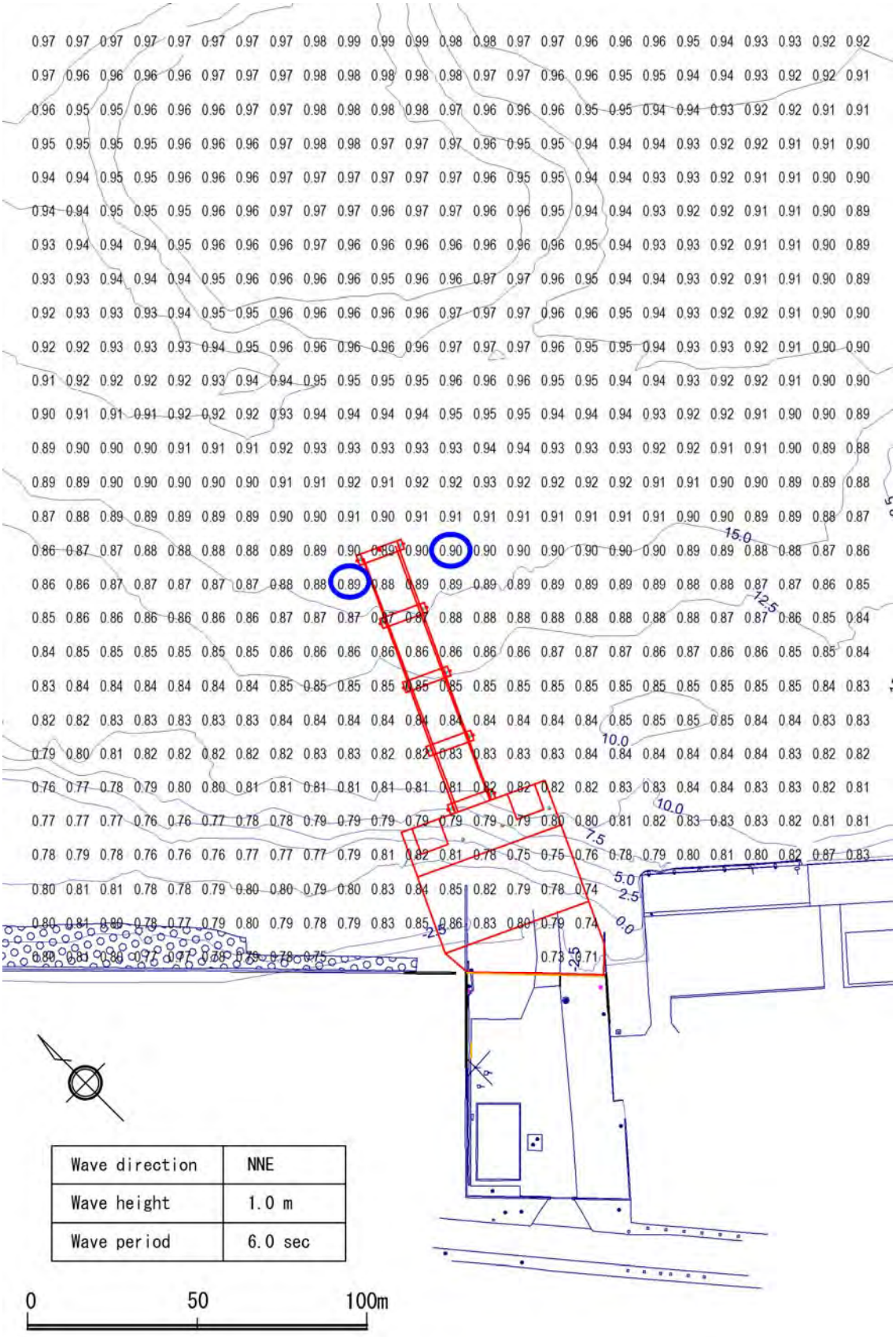


図 5-44　波高比分布（NNE）

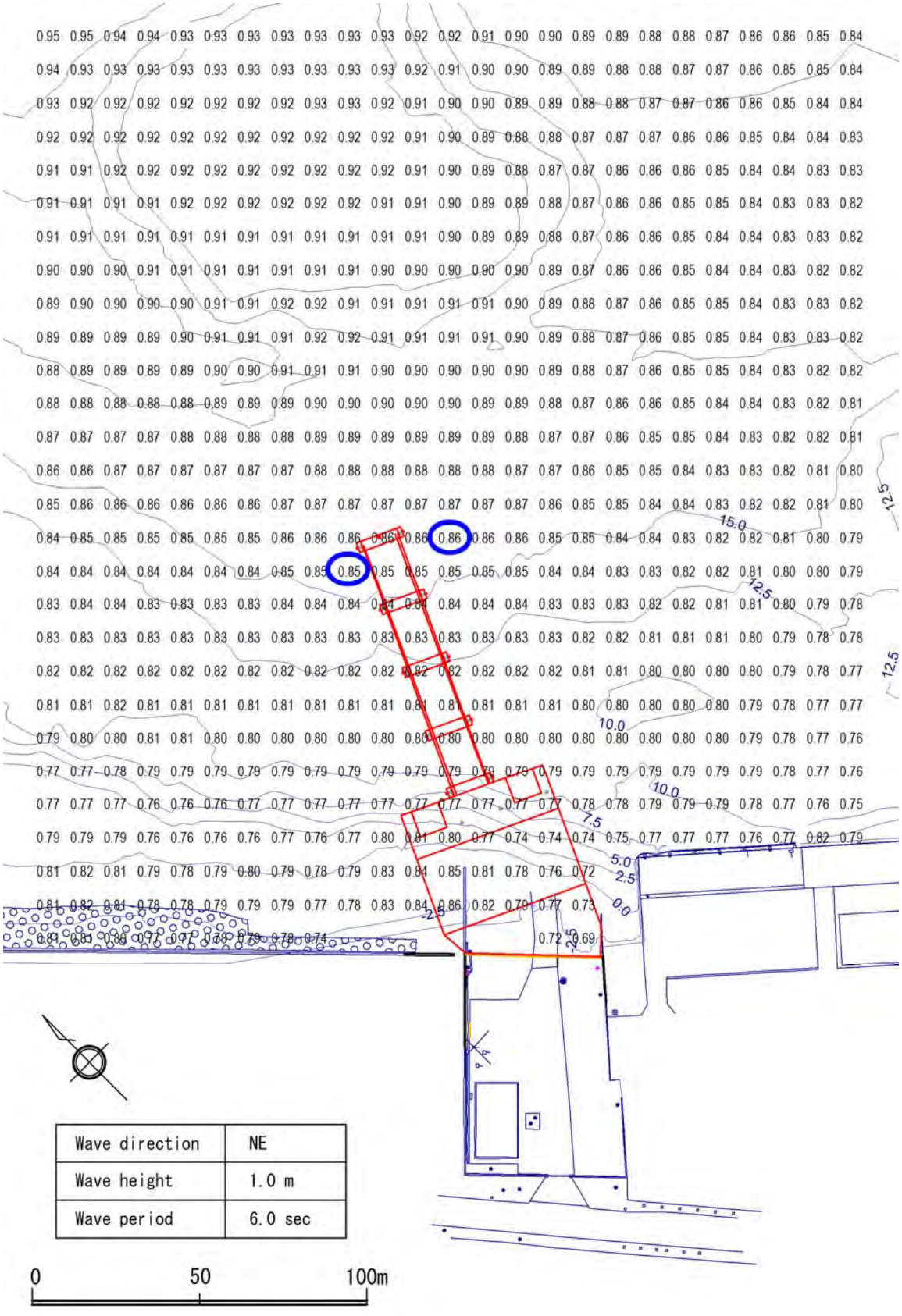


図 5-45　波高比分布（NE）

5-2-2-4-2　　評価エリアの波高比分布

計算結果より評価エリア内の最大値を抽出し、表 5-36 にまとめた。

表 5-36　評価エリア別波高比

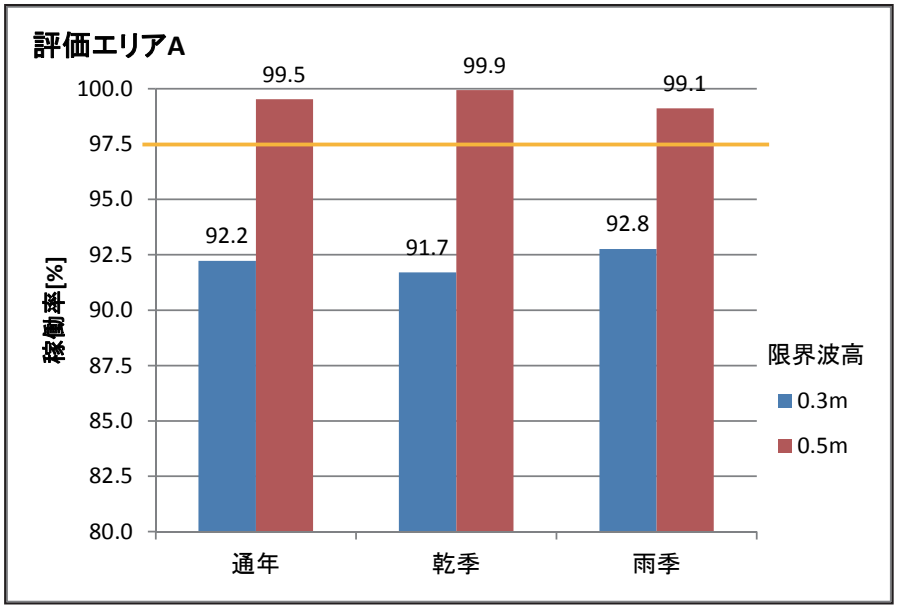
波向	評価エリアA	評価エリアB
NW	0.54	0.54
NNW	0.68	0.68
N	0.81	0.82
NNE	0.89	0.90
NE	0.85	0.86

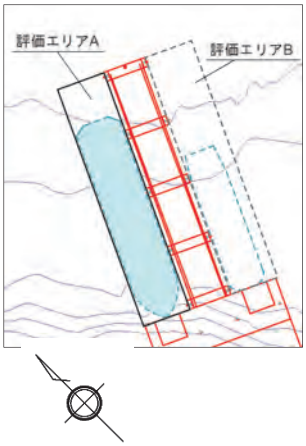
代表周期：6.0s

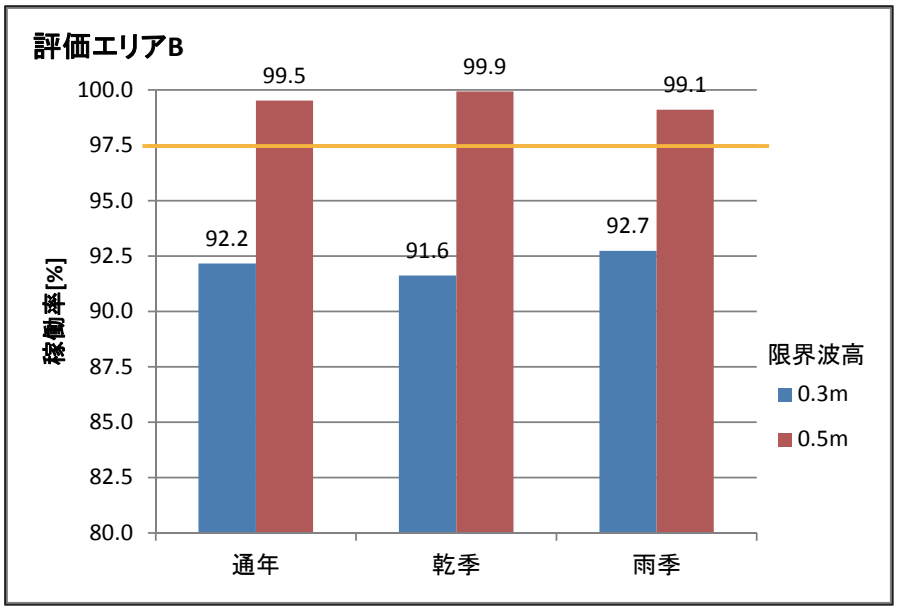
5-2-2-5 稼働率

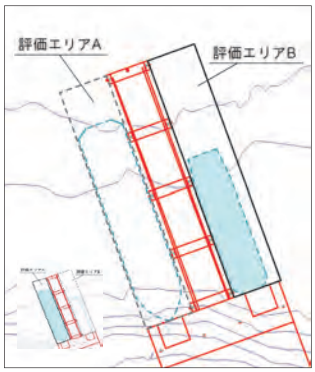
前項までの結果を踏まえて稼働率を算定した結果を図 5-46 に示す。算出にあたっては、限界波高を 0.3m と 0.5m として M1 地点での限界波高（限界波高/波高比）を求め、ついで M1 地点での限界波高以上の出現頻度を求めた。

稼働率は 100%－（M1 地点での限界波高以上の出現頻度）として算出した（付属資料 6 参照）。限界波高 0.5m においては、評価エリア A，B とも稼働率 97.5%を超える結果となった。









乾季：12 月～5 月

雨季：6 月～11 月

図 5-46　季節別稼働率

5-3　　桟橋構造計算結果

5-3-1　　桟橋

5-3-1-1 防舷材の検討

1. 設計条件

項目		設計条件	単位
船種		ナクロマ	
重量トン数	(DWT)	287.00	(t)
総トン数	(GT)	1134.00	(t)
船長	(L)	46.76	(m)
垂線間長	(L_{pp})	41.33	(m)
型幅	(B)	12.00	(m)
型深さ	(D)	10.00	(m)
満載喫水	(d)	2.42	(m)
接岸速度	(V)	0.35	(m/s)

2. 接岸エネルギーの算出
船舶の接岸エネルギーは、下記により算出します。

$$E_f = (M_s \cdot V^2/2) \times C_e \times C_m \times C_s \times C_c$$

ここに、
E_f: 船舶の接岸エネルギー (kJ)
M_s: 船舶の質量 (t)
V: 船舶の接岸速度 (m/s)
C_e: 偏心係数
C_m: 仮想質量係数
C_s: 柔軟性係数(1とします)
C_c: バースの形状係数(1とします)

(1). 船舶の排水量 (M_s)

船舶の排水量は、下記の通りとする。

M_s=925t

(2). 偏心係数

偏心係数は、下記の式により算出します。

$$C_e = 1/[1+(l/r)^2]$$

ここに、
C_e: 偏心係数
l: 船舶の接岸点から係留施設の法線に平行に測った当該船舶の重心までの距離 (
r: 船舶の重心を通る鉛直軸回りの回転半径 (m)

回転半径は、下記の式より算出します。

$$r = (0.19C_b + 0.11)L_{pp}$$
$$= (0.19 \times 0.7518926 + 0.11) \times 41.33$$
$$= 10.45069$$

図1に示すように、船舶がP点で最も係船岸に近づき防舷材F1及びF2に接触するとき、係留施設に平行に測った接岸点から船舶重心までの距離lは、下記の式によって求めます。ただし、lはk＞0.5のときL_1を、k＜0.5のときはL_2を用います。k＝0.5のときは、L_1、L_2のうち、Ceが大きくなる方の値をとります。

$L_1 = \{0.5\alpha + e(1-k)\} L_{pp} \cos\theta$
$L_2 = \{0.5\alpha - ek\} L_{pp} \cos\theta$

ここに、

L_1: 船舶が防舷材F1に接触するときの係留施設に平行に測った接岸点から船舶の重心までの距離 (m)
L_2: 船舶が防舷材F2に接触するときの係留施設に平行に測った接岸点から船舶の重心までの距離 (m)
θ: 接岸角度
e: 船の長手方向に測った防舷材間隔(20m)と垂線間長との比
e＝20/41.33
＝0.48391とします
α: 防舷材との接岸点高さにおける船舶の側面の平行舷(パラレルサイド)の長さと垂線間長との比
α＝0.5とします
k: 防舷材F1とF2の間において船舶と係船岸が最も近づく点を表すパラメーター
k＝0.5とします

k＝0.5ですから、lはL_1、L_2のうち小さい方をを用います。
$L_1 = \{0.5 \times 0.5 + 0.48391 \times (1-0.5)\} \times 41.33 \times \cos(10^\circ)$
＝20.0236
$L_2 = \{0.5 \times 0.5 - 0.48391 \times 0.5\} \times 41.33 \times \cos(10^\circ)$
＝0.3274492

したがって、l＝0.3274492とします。

よって、
$C_e = 1/\{1+(0.3274492/10.45069)^2\}$
＝0.9990192

(3). 仮想質量係数 (C_m)
船舶の仮想質量係数は、下記の式により算出します。

$C_m = 1 + \{\pi/(2 \cdot C_b)\}(d/B)$

ここに、

C_b: ブロック係数
$C_b = \nabla/(L_{pp}Bd)$
∇: 船舶の排水体積 (m^3)
$\nabla = M_s/\omega_0$
L_{pp}: 垂線間長 (m)
B: 型幅 (m)
d: 満載喫水 (m)
ω_0: 海水の単位体積重量 ($1.025t/m^3$)

$C_b = 925/(41.33 \times 12 \times 2.42 \times 1.025)$
＝0.7518926

$C_m = 1 + \{\pi/(2 \times 0.7518926)\} \times (2.42/12)$
＝1.421306

(4). 接岸エネルギー (E_f)

$E_f = (925 \times 0.35^2/2) \times 0.9990192 \times 1.421306 \times 1 \times 1$
＝80.44691(kJ)

1. 設計条件

項目		設計条件	単位
船種		ナクロマ2	
重量トン数	(DWT)	1050.00	(t)
総トン数	(GT)	2359.35	(t)
船長	(L)	67.30	(m)
垂線間長	(L_{pp})	61.20	(m)
型幅	(B)	16.00	(m)
型深さ	(D)	8.90	(m)
満載喫水	(d)	3.30	(m)
接岸速度	(V)	0.35	(m/s)

2. 接岸エネルギーの算出

船舶の接岸エネルギーは、下記により算出します。

$E_f = (M_s \cdot V^2/2) \times C_e \times C_m \times C_s \times C_c$

ここに、

E_f: 船舶の接岸エネルギー (kJ)
M_s: 船舶の質量 (t)
V: 船舶の接岸速度 (m/s)
C_e: 偏心係数
C_m: 仮想質量係数
C_s: 柔軟性係数(1とします)
C_c: バースの形状係数(1とします)

(1). 船舶の排水量 (M_s)

船舶の排水量は、下記の通りとする。

M_s=2,503t

(2). 偏心係数

偏心係数は、下記の式により算出します。

$C_e = 1/[1+(l/r)^2]$

ここに、

C_e: 偏心係数
l: 船舶の接岸点から係留施設の法線に平行に測った当該船舶の重心までの距離 (
r: 船舶の重心を通る鉛直軸回りの回転半径 (m)

回転半径は、下記の式より算出します。

$r = (0.19C_b + 0.11)L_{pp}$
$= (0.19 \times 0.7557039 + 0.11) \times 61.2$
$= 6.732$

図1に示すように、船舶がP点で最も係船岸に近づき防舷材F1及びF2に接触するとき、係留施設に平行に測った接岸点から船舶重心までの距離lは、下記の式によって求めます。ただし、lはk＞0.5のときL_1を、k＜0.5のときはL_2を用います。k＝0.5のときは、L_1、L_2のうち、Ceが大きくなる方の値をとります。

$L_1 = \{0.5\alpha + e(1-k)\} L_{pp} \cos\theta$
$L_2 = \{0.5\alpha - ek\} L_{pp} \cos\theta$

ここに、

L_1: 船舶が防舷材F1に接触するときの係留施設に平行に測った接岸点から船舶の重心までの距離 (m)

L_2: 船舶が防舷材F2に接触するときの係留施設に平行に測った接岸点から船舶の重心までの距離 (m)

θ: 接岸角度

e: 船の長手方向に測った防舷材間隔(20m)と垂線間長との比
e=20/61.2
=0.326797とします

α: 防舷材との接岸点高さにおける船舶の側面の平行舷(パラレルサイド)の長さと垂線間長との比
α=0.5とします

k: 防舷材F1とF2の間において船舶と係船岸が最も近づく点を表すパラメーター
k=0.5とします

k=0.5ですから、lはL_1、L_2のうち小さい方をを用います。
$L_1 = \{0.5 \times 0.5 + 0.3267974 \times (1-0.5)\} \times 61.2 \times \cos(10^\circ)$
=24.91564
$L_2 = \{0.5 \times 0.5 - 0.3267974 \times 0.5\} \times 61.2 \times \cos(10^\circ)$
=5.219481

したがって、l=5.219481とします。

よって、
$C_e = 1/\{1+(5.219481/6.732)^2\}$
=0.6245599

(3). 仮想質量係数 (C_m)

船舶の仮想質量係数は、下記の式により算出します。

$C_m = 1 + \{\pi/(2 \cdot C_b)\}(d/B)$
ここに、

C_b: ブロック係数
$C_b = \nabla/(L_{pp}Bd)$

∇: 船舶の排水体積 (m^3)
$\nabla = M_s/\omega_0$

L_{pp}: 垂線間長 (m)

B: 型幅 (m)

d: 満載喫水 (m)

ω_0: 海水の単位体積重量 ($1.025t/m^3$)

$C_b = 2503/(61.2 \times 16 \times 3.3 \times 1.025)$
=0.7557039

$C_m = 1 + \{\pi/(2 \times 0.7557039)\} \times (3.3/16)$
=1.428709

(4). 接岸エネルギー (E_f)

$E_f = (2503 \times 0.35^2/2) \times 0.6245599 \times 1.428709 \times 1 \times 1$
=136.7996(kJ)

1. 設計条件

項目		設計条件	単位
船種		ポルトガルフェリー	
重量トン数	(DWT)	0.00	(t)
総トン数	(GT)	0.00	(t)
船長	(L)	71.30	(m)
垂線間長	(L_{pp})	59.34	(m)
型幅	(B)	12.60	(m)
型深さ	(D)	10.00	(m)
満載喫水	(d)	3.70	(m)
接岸速度	(V)	0.35	(m/s)

2. 接岸エネルギーの算出
船舶の接岸エネルギーは、下記により算出します。

$E_f = (M_s \cdot V^2/2) \times C_e \times C_m \times C_s \times C_c$

ここに、
E_f: 船舶の接岸エネルギー (kJ)
M_s: 船舶の質量 (t)
V: 船舶の接岸速度 (m/s)
C_e: 偏心係数
C_m: 仮想質量係数
C_s: 柔軟性係数(1とします)
C_c: バースの形状係数(1とします)

(1). 船舶の排水量 (M_s)

船舶の排水量は、下記の通りとする。

M_s=2,870t

(2). 偏心係数

偏心係数は、下記の式により算出します。

$C_e = 1/\{1+(l/r)^2\}$
ここに、
C_e: 偏心係数
l: 船舶の接岸点から係留施設の法線に平行に測った当該船舶の重心までの距離 (
r: 船舶の重心を通る鉛直軸回りの回転半径 (m)

回転半径は、下記の式より算出します。

$r = (0.19C_b + 0.11)L_{pp}$
$= (0.19 \times 1.012134 + 0.11) \times 59.34$
$= 17.93881$

図1に示すように、船舶がP点で最も係船岸に近づき防舷材F1及びF2に接触するとき、係留施設に平行に測った接岸点から船舶重心までの距離lは、下記の式によって求めます。ただし、lはk＞0.5のときL_1を、k＜0.5のときはL_2を用います。k＝0.5のときは、L_1、L_2のうち、Ceが大きくなる方の値をとります。

$L_1 = \{0.5\alpha + e(1-k)\} L_{pp} \cos\theta$
$L_2 = \{0.5\alpha - ek\} L_{pp} \cos\theta$

ここに、

L_1: 船舶が防舷材F1に接触するときの係留施設に平行に測った接岸点から船舶の重心までの距離 (m)

L_2: 船舶が防舷材F2に接触するときの係留施設に平行に測った接岸点から船舶の重心までの距離 (m)

θ: 接岸角度

e: 船の長手方向に測った防舷材間隔(20m)と垂線間長との比
e＝20/59.34
＝0.337041とします

α: 防舷材との接岸点高さにおける船舶の側面の平行舷(パラレルサイド)の長さと垂線間長との比
α＝0.5とします

k: 防舷材F1とF2の間において船舶と係船岸が最も近づく点を表すパラメーター
k＝0.5とします

k＝0.5ですから、lはL_1、L_2のうち小さい方をを用います。

$L_1 = \{0.5 \times 0.5 + 0.3370408 \times (1-0.5)\} \times 59.34 \times \cos(10^\circ)$
＝24.4577

$L_2 = \{0.5 \times 0.5 - 0.3370408 \times 0.5\} \times 59.34 \times \cos(10^\circ)$
＝4.761546

したがって、l＝4.761546とします。

よって、

$C_e = 1/\{1+(4.761546/17.93881)^2\}$
＝0.9341826

(3). 仮想質量係数 (C_m)

船舶の仮想質量係数は、下記の式により算出します。

$C_m = 1 + \{\pi/(2 \cdot C_b)\}(d/B)$

ここに、

C_b: ブロック係数
$C_b = \nabla/(L_{pp}Bd)$

∇: 船舶の排水体積 (m^3)
$\nabla = M_s/\omega_0$

L_{pp}: 垂線間長 (m)

B: 型幅 (m)

d: 満載喫水 (m)

ω_0: 海水の単位体積重量 ($1.025t/m^3$)

$C_b = 2870/(59.34 \times 12.6 \times 3.7 \times 1.025)$
＝1.012134

$C_m = 1 + \{\pi/(2 \times 1.012134)\} \times (3.7/12.6)$
＝1.455735

(4). 接岸エネルギー (E_f)

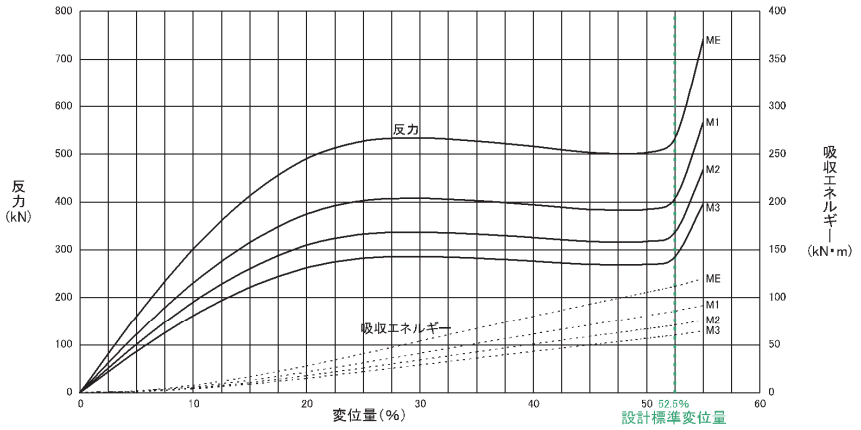
$E_f = (2870 \times 0.35^2/2) \times 0.9341826 \times 1.455735 \times 1 \times 1$
＝239.0574(kJ)

■ DA-A500H圧縮性能

■性能グレード：Mシリーズ

性能グレード	ME		M1		M2		M3	
設計標準変位量	52.5%		52.5%		52.5%		52.5%	
項目 / 長さ	反力	吸収エネルギー	反力	吸収エネルギー	反力	吸収エネルギー	反力	吸収エネルギー
	(kN)	(kN･m)	(kN)	(kN･m)	(kN)	(kN･m)	(kN)	(kN･m)
1000mm	534	112	408	85.7	337	70.9	286	60.2
1500mm	801	168	612	129	506	106	429	90.3
2000mm	1070	224	816	171	674	142	572	120
2500mm	1340	280	1020	214	843	177	715	151
3000mm	1600	336	1220	257	1011	213	858	181
3500mm	1870	392	1430	300	1180	248	1000	211

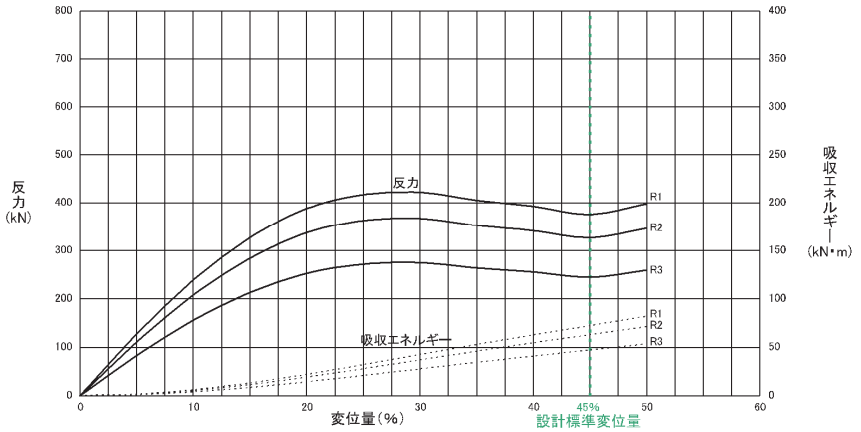
性能公差：反力＋10%以下／吸収エネルギー－10%以上



■性能グレード：Rシリーズ

性能グレード	R1		R2		R3	
設計標準変位量	45.0%		45.0%		45.0%	
項目 / 長さ	反力	吸収エネルギー	反力	吸収エネルギー	反力	吸収エネルギー
	(kN)	(kN･m)	(kN)	(kN･m)	(kN)	(kN･m)
1000mm	422	72.5	367	63.1	275	47.3
1500mm	633	109	551	94.7	413	71.0
2000mm	844	145	734	126	550	94.6
2500mm	1060	181	918	158	688	118
3000mm	1270	218	1100	189	825	142
3500mm	1480	254	1280	221	963	166

性能公差：反力＋10%以下／吸収エネルギー－10%以上



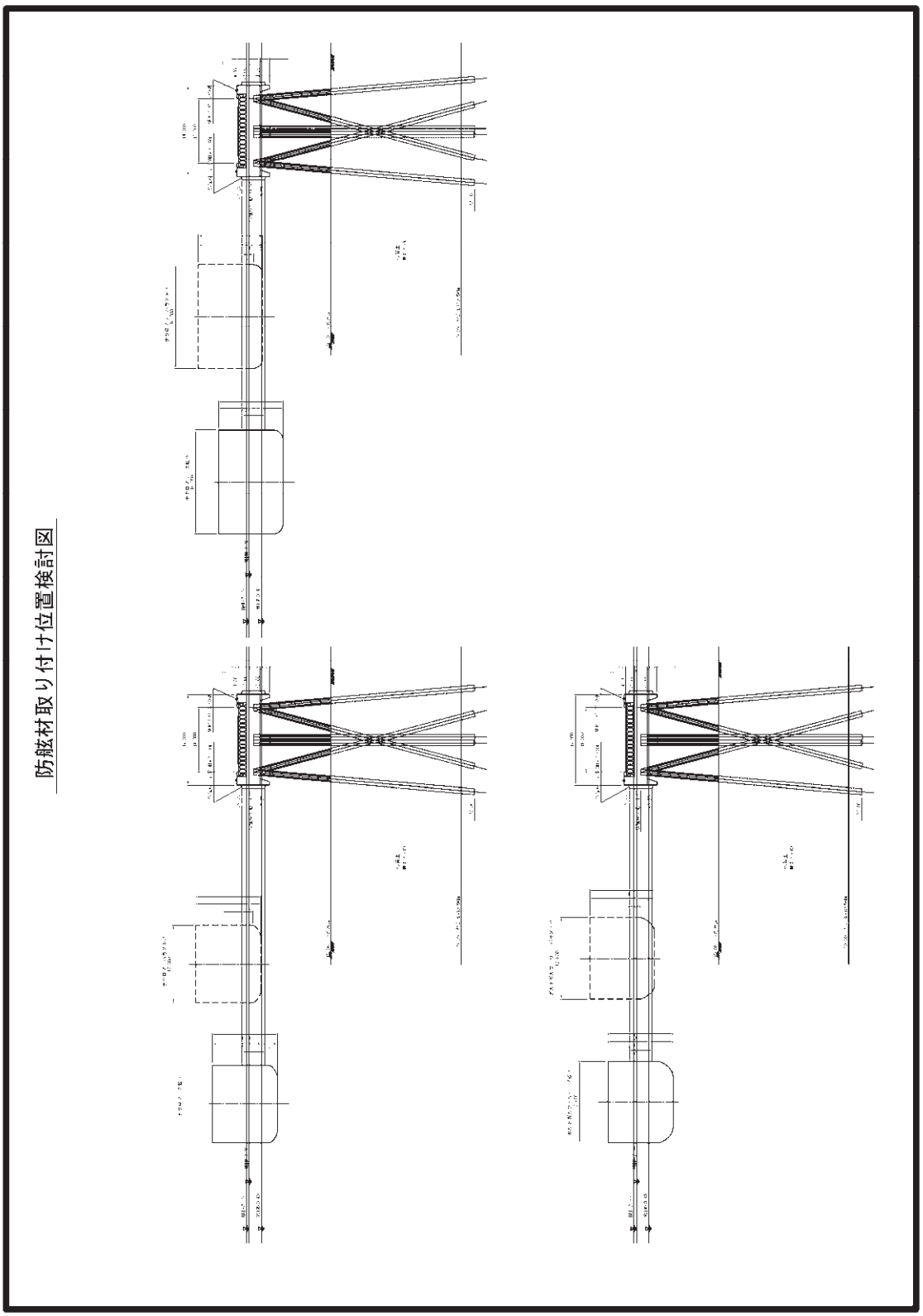


図 5-48　防舷材取付け位置検討図

表 5-37(1/2)　耐力照査(BH-3、接岸時)

三次元杭基礎の設計

1. 入力条件

Ship

Xo=	818.000	kN
Yo=	17,648.000	kN
Zo=	-2,045.000	kN
Mx=	2,751.000	kN-m
My=	0.000	kN-m
Mz=	493.000	kN-m
杭本数 n=	10	
Kh=	4.930	N/cm^3
有効座屈長	h	

BD BH3 接岸時 (1/4)

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	0.000	0.000	10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
2	0.000	0.000	9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
3	0.450	0.000	5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
4	-0.450	0.000	5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
5	0.000	0.000	0.450	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
6	0.000	0.000	-0.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
7	0.450	0.000	-5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
8	-0.450	0.000	-5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
9	0.000	0.000	-9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
10	0.000	0.000	-10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900

2. バネ定数

BD BH3 接岸時 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
2	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
3	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
4	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
5	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
6	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
7	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
8	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
9	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
10	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50

3. 杭応力

BD BH3 接岸時 (3/4)

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	16.812	2,058.323	-45.470	-407.924	-0.893	-183.118	447.140	42.27	67	67	202	235
2	-23.670	1,332.325	45.795	411.877	-2.025	245.131	479.306	42.27	43	71	202	235
3	40.586	3,306.366	20.763	218.295	4.731	-364.166	424.595	42.27	108	63	202	235
4	-47.704	214.166	-20.438	-214.341	-7.649	428.533	479.178	42.27	7	71	202	235
5	-24.516	1,428.662	45.795	411.877	-2.025	252.788	483.267	42.27	47	72	202	235
6	17.259	2,226.079	-45.470	-407.924	-0.893	-187.160	448.810	42.27	73	67	202	235
7	40.326	3,436.251	21.457	224.570	4.731	-361.813	425.854	42.27	112	63	202	235
8	-47.964	344.051	-21.132	-220.616	-7.649	430.886	484.111	42.27	11	72	202	235
9	-25.447	1,534.525	45.795	411.877	-2.025	261.202	487.721	42.27	50	73	202	235
10	17.669	2,379.984	-45.470	-407.924	-0.893	-190.868	450.369	42.27	78	67	202	235

4. 杭の応力判定及び変位量

BD BH3 接岸時 (4/4)

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.9000	0.0120	0.617	0.009016	0.011106	-0.039471
2	0.9000	0.0120	0.519	0.009069	0.011182	-0.039471
3	0.9000	0.0120	0.804	0.009337	0.011151	-0.039444
4	0.9000	0.0120	0.338	0.009337	0.011990	-0.039497
5	0.9000	0.0120	0.538	0.009605	0.011959	-0.039471
6	0.9000	0.0120	0.645	0.009658	0.012036	-0.039471
7	0.9000	0.0120	0.826	0.009926	0.012004	-0.039444
8	0.9000	0.0120	0.362	0.009926	0.012843	-0.039497
9	0.9000	0.0120	0.558	0.010194	0.012812	-0.039471
10	0.9000	0.0120	0.671	0.010247	0.012889	-0.039471

原点の変位					
x_0	(m)	0.009632	α_0	(rad)	0.000085
y_0	(m)	0.011997	β_0	(rad)	-0.000059
z_0	(m)	-0.039471	γ_0	(rad)	-0.000933

三次元杭基礎の設計

1. 入力条件

L1

Xo=	0.000	kN
Yo=	13,648.000	kN
Zo=	2,047.000	kN
Mx=	-2,047.000	kN-m
My=	0.000	kN-m
Mz=	0.000	kN-m
杭本数 n=	10	
Kh=	5.900	N/cm^3
有効座屈長	h	

BD BH3 地震時_橋軸直角方向 (1/4)

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	0.000	0.000	10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
2	0.450	0.000	9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
3	0.450	0.000	5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
4	-0.450	0.000	5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
5	0.000	0.000	0.450	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
6	0.000	0.000	-0.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
7	0.450	0.000	-5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
8	-0.450	0.000	-5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
9	0.000	0.000	-9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
10	0.000	0.000	-10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900

2. バネ定数

BD BH3 地震時_橋軸直角方向 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
2	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
3	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
4	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
5	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
6	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
7	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
8	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
9	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
10	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50

3. 杭応力

BD BH3 地震時_橋軸直角方向 (3/4)

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	-19.298	1,624.393	48.603	432.213	-0.985	232.166	490.622	42.27	53	73	202	235
2	12.741	1,512.597	-48.499	-430.933	-0.031	-173.568	464.574	42.27	49	69	202	235
3	-50.131	-66.337	-15.180	-193.150	-12.394	445.614	485.753	42.27	2	72	235	235
4	44.052	2,973.954	15.294	194.530	11.379	-391.285	437.048	42.27	97	65	202	235
5	12.980	1,285.437	-48.488	-430.833	-0.031	-175.706	465.285	42.27	42	69	202	235
6	-18.791	1,515.522	48.603	432.213	-0.985	227.637	488.494	42.27	49	73	202	235
7	-49.906	-174.483	-14.931	-190.932	-12.394	443.601	483.026	42.27	6	72	235	235
8	44.277	2,865.809	15.046	192.312	11.379	-393.298	437.872	42.27	93	65	202	235
9	12.966	1,169.028	-48.488	-430.833	-0.031	-175.577	465.236	42.27	38	69	202	235
10	-18.326	1,415.641	48.603	432.213	-0.985	223.481	486.572	42.27	46	72	202	235

4. 杭の応力判定及び変位量

BD BH3 地震時_橋軸直角方向 (4/4)

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.9000	0.0120	0.574	0.002728	0.009940	0.040241
2	0.9000	0.0120	0.539	0.002746	0.010672	0.040250
3	0.9000	0.0120	0.317	0.002838	0.010349	0.040250
4	0.9000	0.0120	0.758	0.002838	0.008756	0.040231
5	0.9000	0.0120	0.503	0.002931	0.009229	0.040241
6	0.9000	0.0120	0.555	0.002949	0.009166	0.040241
7	0.9000	0.0120	0.330	0.003041	0.009639	0.040250
8	0.9000	0.0120	0.741	0.003041	0.008046	0.040231
9	0.9000	0.0120	0.484	0.003133	0.008519	0.040241
10	0.9000	0.0120	0.538	0.003151	0.008455	0.040241

原点の変位					
x_0	(m)	0.002940	α_0	(rad)	-0.000071
y_0	(m)	0.009198	β_0	(rad)	-0.000020
z_0	(m)	0.040241	γ_0	(rad)	0.001770

三次元杭基礎の設計

1. 入力条件

L1

Xo=	2,047.000	kN
Yo=	13,648.000	kN
Zo=	0.000	kN
Mx=	0.000	kN-m
My=	0.000	kN-m
Mz=	2,047.000	kN-m
杭本数 n=	10	
Kh=	5.900	N/cm^3
有効座屈長	h	

BD BH3 地震時_橋軸方向 (1/4)

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	0.000	0.000	10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
2	0.000	0.000	9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
3	0.450	0.000	5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
4	-0.450	0.000	5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
5	0.000	0.000	0.450	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
6	0.000	0.000	-0.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
7	0.450	0.000	-5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
8	-0.450	0.000	-5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
9	0.000	0.000	-9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
10	0.000	0.000	-10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900

2. バネ定数

BD BH3 地震時_橋軸方向 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
2	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
3	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
4	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
5	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
6	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
7	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
8	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
9	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
10	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50

3. 杭応力

BD BH3 地震時_橋軸方向 (3/4)

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	-10.895	2,777.778	6.728	59.921	-1.928	240.098	247.466	42.27	91	37	202	235
2	4.777	121.047	-6.330	-55.141	-1.590	-185.424	193.452	42.27	4	29	202	235
3	-9.911	1,493.830	-4.268	-175.397	-30.176	87.725	197.265	42.27	49	29	202	235
4	3.873	1,366.706	4.665	180.176	26.658	-33.763	184.276	42.27	45	27	202	235
5	4.094	60.158	-6.330	-55.141	-1.590	-179.319	187.609	42.27	2	28	202	235
6	-9.903	2,767.242	6.728	59.921	-1.928	231.233	238.874	42.27	90	36	202	235
7	-9.831	1,455.542	-3.408	-167.714	-30.176	87.012	190.139	42.27	47	28	202	235
8	3.953	1,328.418	3.806	172.494	26.658	-34.476	176.909	42.27	43	26	202	235
9	3.343	-6.753	-6.330	-55.141	-1.590	-172.611	181.208	42.27	0	27	235	235
10	-8.993	2,757.577	6.728	59.921	-1.928	223.099	231.010	42.27	90	34	202	235

4. 杭の応力判定及び変位量

BD BH3 地震時_橋軸方向 (4/4)

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.9000	0.0120	0.607	0.032493	0.009541	0.005547
2	0.9000	0.0120	0.142	0.032556	0.009519	0.005547
3	0.9000	0.0120	0.367	0.032875	0.011308	0.005579
4	0.9000	0.0120	0.338	0.032875	0.007500	0.005515
5	0.9000	0.0120	0.129	0.033195	0.009290	0.005547
6	0.9000	0.0120	0.599	0.033258	0.009267	0.005547
7	0.9000	0.0120	0.356	0.033577	0.011056	0.005579
8	0.9000	0.0120	0.327	0.033577	0.007249	0.005515
9	0.9000	0.0120	0.116	0.033896	0.009038	0.005547
10	0.9000	0.0120	0.593	0.033960	0.009016	0.005547

原点の変位					
x_0	(m)	0.033226	α_0	(rad)	-0.000025
y_0	(m)	0.009278	β_0	(rad)	-0.000070
z_0	(m)	0.005547	γ_0	(rad)	0.004231

三次元杭基礎の設計

1. 入力条件

Ship

Xo=	818.000	kN
Yo=	17,648.000	kN
Zo=	-2,045.000	kN
Mx=	2,751.000	kN-m
My=	0.000	kN-m
Mz=	493.000	kN-m
杭本数 n=	10	
Kh=	4.930	N/cm^3
有効座屈長	h	

BD BH4 接岸時 (1/4)

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	0.000	0.000	10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
2	0.000	0.000	9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
3	0.450	0.000	5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
4	-0.450	0.000	5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
5	0.000	0.000	0.450	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
6	0.000	0.000	-0.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
7	0.450	0.000	-5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
8	-0.450	0.000	-5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
9	0.000	0.000	-9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
10	0.000	0.000	-10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900

2. バネ定数

BD BH4 接岸時 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
2	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
3	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
4	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
5	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
6	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
7	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
8	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
9	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50
10	306.53	6,715	301,502	0.2071	1,178.36	1,178.36	10,655.68	10,655.68	129,698.94	129,698.94	25,647.41	157,596.50

3. 杭応力

BD BH4 接岸時 (3/4)

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	16.812	2,058.323	-45.470	-407.924	-0.893	-183.118	447.140	42.27	67	67	202	235
2	-23.670	1,332.325	45.795	411.877	-2.025	245.131	479.306	42.27	43	71	202	235
3	40.586	3,306.366	20.763	218.295	4.731	-364.166	424.595	42.27	108	63	202	235
4	-47.704	214.166	-20.438	-214.341	-7.649	428.533	479.178	42.27	7	71	202	235
5	-24.516	1,428.662	45.795	411.877	-2.025	252.788	483.267	42.27	47	72	202	235
6	17.259	2,226.079	-45.470	-407.924	-0.893	-187.160	448.810	42.27	73	67	202	235
7	40.326	3,436.251	21.457	224.570	4.731	-361.813	425.854	42.27	112	63	202	235
8	-47.964	344.051	-21.132	-220.616	-7.649	430.886	484.111	42.27	11	72	202	235
9	-25.447	1,534.525	45.795	411.877	-2.025	261.202	487.721	42.27	50	73	202	235
10	17.669	2,379.984	-45.470	-407.924	-0.893	-190.868	450.369	42.27	78	67	202	235

4. 杭の応力判定及び変位量

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.9000	0.0120	0.617	0.009016	0.011106	-0.039471
2	0.9000	0.0120	0.519	0.009069	0.011182	-0.039471
3	0.9000	0.0120	0.804	0.009337	0.011151	-0.039444
4	0.9000	0.0120	0.338	0.009337	0.011990	-0.039497
5	0.9000	0.0120	0.538	0.009605	0.011959	-0.039471
6	0.9000	0.0120	0.645	0.009658	0.012036	-0.039471
7	0.9000	0.0120	0.826	0.009926	0.012004	-0.039444
8	0.9000	0.0120	0.362	0.009926	0.012843	-0.039497
9	0.9000	0.0120	0.558	0.010194	0.012812	-0.039471
10	0.9000	0.0120	0.671	0.010247	0.012889	-0.039471

BD BH4 接岸時 (4/4)

原点の変位					
x_0	(m)	0.009632	α_0	(rad)	0.000085
y_0	(m)	0.011997	β_0	(rad)	-0.000059
z_0	(m)	-0.039471	γ_0	(rad)	-0.000933

三次元杭基礎の設計

1. 入力条件

L1

Xo=	0.000	kN
Yo=	13,648.000	kN
Zo=	2,047.000	kN
Mx=	-2,047.000	kN-m
My=	0.000	kN-m
Mz=	0.000	kN-m
杭本数 n=	10	
Kh=	5.900	N/cm^3
有効座屈長	h	

BD BH4 地震時_橋軸直角方向 (1/4)

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	0.000	0.000	10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
2	0.450	0.000	9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
3	0.450	0.000	5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
4	-0.450	0.000	5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
5	0.000	0.000	0.450	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
6	0.000	0.000	-0.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
7	0.450	0.000	-5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
8	-0.450	0.000	-5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
9	0.000	0.000	-9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
10	0.000	0.000	-10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900

2. バネ定数

BD BH4 地震時_橋軸直角方向 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
2	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
3	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
4	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
5	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
6	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
7	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
8	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
9	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
10	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50

3. 杭応力

BD BH4 地震時_橋軸直角方向 (3/4)

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	-19.298	1,624.393	48.603	432.213	-0.985	232.166	490.622	42.27	53	73	202	235
2	12.741	1,512.597	-48.499	-430.933	-0.031	-173.568	464.574	42.27	49	69	202	235
3	-50.131	-66.337	-15.180	-193.150	-12.394	445.614	485.753	42.27	2	72	235	235
4	44.052	2,973.954	15.294	194.530	11.379	-391.285	437.048	42.27	97	65	202	235
5	12.980	1,285.437	-48.488	-430.833	-0.031	-175.706	465.285	42.27	42	69	202	235
6	-18.791	1,515.522	48.603	432.213	-0.985	227.637	488.494	42.27	49	73	202	235
7	-49.906	-174.483	-14.931	-190.932	-12.394	443.601	483.026	42.27	6	72	235	235
8	44.277	2,865.809	15.046	192.312	11.379	-393.298	437.872	42.27	93	65	202	235
9	12.966	1,169.028	-48.488	-430.833	-0.031	-175.577	465.236	42.27	38	69	202	235
10	-18.326	1,415.641	48.603	432.213	-0.985	223.481	486.572	42.27	46	72	202	235

4. 杭の応力判定及び変位量

BD BH4 地震時_橋軸直角方向 (4/4)

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.9000	0.0120	0.574	0.002728	0.009940	0.040241
2	0.9000	0.0120	0.539	0.002746	0.010672	0.040250
3	0.9000	0.0120	0.317	0.002838	0.010349	0.040250
4	0.9000	0.0120	0.758	0.002838	0.008756	0.040231
5	0.9000	0.0120	0.503	0.002931	0.009229	0.040241
6	0.9000	0.0120	0.555	0.002949	0.009166	0.040241
7	0.9000	0.0120	0.330	0.003041	0.009639	0.040250
8	0.9000	0.0120	0.741	0.003041	0.008046	0.040231
9	0.9000	0.0120	0.484	0.003133	0.008519	0.040241
10	0.9000	0.0120	0.538	0.003151	0.008455	0.040241

原点の変位					
x_0	(m)	0.002940	α_0	(rad)	-0.000071
y_0	(m)	0.009198	β_0	(rad)	-0.000020
z_0	(m)	0.040241	γ_0	(rad)	0.001770

三次元杭基礎の設計

1. 入力条件

L1

Xo=	2,047.000	kN
Yo=	13,648.000	kN
Zo=	0.000	kN
Mx=	0.000	kN-m
My=	0.000	kN-m
Mz=	2,047.000	kN-m
杭本数 n=	10	
Kh=	5.900	N/cm^3
有効座屈長	h	

BD BH4 地震時_橋軸方向 (1/4)

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	0.000	0.000	10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
2	0.000	0.000	9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
3	0.450	0.000	5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
4	-0.450	0.000	5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
5	0.000	0.000	0.450	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
6	0.000	0.000	-0.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
7	0.450	0.000	-5.000	15.00	270.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
8	-0.450	0.000	-5.000	15.00	90.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
9	0.000	0.000	-9.550	15.00	180.00	0.9000	0.012	0.0010	SKK400	13.257	38.900
10	0.000	0.000	-10.450	15.00	0.00	0.9000	0.012	0.0010	SKK400	13.257	38.900

2. バネ定数

BD BH4 地震時_橋軸方向 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
2	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
3	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
4	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
5	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
6	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
7	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
8	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
9	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50
10	306.53	6,715	301,502	0.2166	1,225.04	1,225.04	10,947.95	10,947.95	131,576.71	131,576.71	25,951.65	157,596.50

3. 杭応力

BD BH4 地震時_橋軸方向 (3/4)

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	-10.895	2,777.778	6.728	59.921	-1.928	240.098	247.466	42.27	91	37	202	235
2	4.777	121.047	-6.330	-55.141	-1.590	-185.424	193.452	42.27	4	29	202	235
3	-9.911	1,493.830	-4.268	-175.397	-30.176	87.725	197.265	42.27	49	29	202	235
4	3.873	1,366.706	4.665	180.176	26.658	-33.763	184.276	42.27	45	27	202	235
5	4.094	60.158	-6.330	-55.141	-1.590	-179.319	187.609	42.27	2	28	202	235
6	-9.903	2,767.242	6.728	59.921	-1.928	231.233	238.874	42.27	90	36	202	235
7	-9.831	1,455.542	-3.408	-167.714	-30.176	87.012	190.139	42.27	47	28	202	235
8	3.953	1,328.418	3.806	172.494	26.658	-34.476	176.909	42.27	43	26	202	235
9	3.343	-6.753	-6.330	-55.141	-1.590	-172.611	181.208	42.27	0	27	235	235
10	-8.993	2,757.577	6.728	59.921	-1.928	223.099	231.010	42.27	90	34	202	235

4. 杭の応力判定及び変位量

BD BH4 地震時_橋軸方向 (4/4)

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.9000	0.0120	0.607	0.032493	0.009541	0.005547
2	0.9000	0.0120	0.142	0.032556	0.009519	0.005547
3	0.9000	0.0120	0.367	0.032875	0.011308	0.005579
4	0.9000	0.0120	0.338	0.032875	0.007500	0.005515
5	0.9000	0.0120	0.129	0.033195	0.009290	0.005547
6	0.9000	0.0120	0.599	0.033258	0.009267	0.005547
7	0.9000	0.0120	0.356	0.033577	0.011056	0.005579
8	0.9000	0.0120	0.327	0.033577	0.007249	0.005515
9	0.9000	0.0120	0.116	0.033896	0.009038	0.005547
10	0.9000	0.0120	0.593	0.033960	0.009016	0.005547

原点の変位					
x_0	(m)	0.033226	α_0	(rad)	-0.000025
y_0	(m)	0.009278	β_0	(rad)	-0.000070
z_0	(m)	0.005547	γ_0	(rad)	0.004231

表 5-43　BH-3　接岸時支持力算定結果

杭の静的最大軸方向押込み抵抗力及び静的最大引抜き抵抗力

1.杭諸元

杭径(mm)	肉厚(mm)	斜角(°)	腐食代(mm)
900	12	15	0

2.先端抵抗力R_{pk}

$R_{pk}=300NAp\alpha$

$R_{pk}=6CpAp\alpha$

N	Cp	A_p (m^2)	閉塞率(α)	R_{pk} (kN)
50		0.636	0.400	3,817.0

3.周面抵抗力R_{fk}

$R_{fk}=\Sigma r_{fki}A_{si}$

$r_{fki}=2N$

$r_{fki}=C_a$

No.	上端 (m)	下端 (m)	層厚 li (m)	層厚 li/cos θ (m)	A_s (m^2)	N	C (kN/m^2)	$2NA_s$ (kN)	C_aA_s (kN)
①	-11.20	-14.40	3.20	3.31	9.367		35.0	0.0	327.8
②	-14.40	-18.00	3.60	3.73	10.538	4.0		84.3	0.0
③	-18.00	-33.80	15.80	16.36	46.249		65.0	0.0	3,006.2
④	-33.80	-36.00	2.20	2.28	6.440	50.0		644.0	0.0
⑤									
⑥									
⑦									
⑧									
⑨									
⑩									
R_{fk}, R_{tk}								4,062.3	

4.静的最大軸方向押込み抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_c)\times(R_{pk}+R_{fk})$						$\gamma_a \cdot R_{td}$
0.66	1.0	× (	3,817.0	+	4,062.3	)= 7,879.4	5,200.4

5.静的最大引抜き抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_c)\times R_{fk}$					$\gamma_a \cdot R_{td}$
0.40	1.0	×	4,062.3	=	4,062.3	1,624.9

表 5-44　BH-3　地震時支持力算定結果

杭の静的最大軸方向押込み抵抗力及び静的最大引抜き抵抗力

1.杭諸元

杭径(mm)	肉厚(mm)	斜角(°)	腐食代(mm)
900	12	15	0

2.先端抵抗力R_{pk}

$R_{pk}=300NAp\alpha$

$R_{pk}=6CpAp\alpha$

N	Cp	A_p (m^2)	閉塞率(α)	R_{pk} (kN)
50		0.636	0.400	3,817.0

3.周面抵抗力R_{fk}

$R_{fk}=\Sigma r_{fki}A_{si}$

$r_{fki}=2N$

$r_{fki}=C_a$

No.	上端 (m)	下端 (m)	層厚 li (m)	層厚 li/cos θ (m)	A_s (m^2)	N	C (kN/m^2)	$2NA_s$ (kN)	C_aA_s (kN)
①	-11.20	-14.40	3.20	3.31	9.367		35.0	0.0	327.8
②	-14.40	-18.00	3.60	3.73	10.538	4.0		84.3	0.0
③	-18.00	-33.80	15.80	16.36	46.249		65.0	0.0	3,006.2
④	-33.80	-36.00	2.20	2.28	6.440	50.0		644.0	0.0
⑤									
⑥									
⑦									
⑧									
⑨									
⑩									
R_{fk}, R_{tk}								4,062.3	

4.静的最大軸方向押込み抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_{c'})\times(R_{pk}+R_{fk})$					$\gamma_a \cdot R_{td}$
0.66	1.0	×(	3,817.0 ＋	4,062.3	)= 7,879.4	5,200.4

5.静的最大引抜き抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_{c'})\times R_{fk}$				$\gamma_a \cdot R_{td}$
0.40	1.0	×	4,062.3 =	4,062.3	1,624.9

表 5-45　BH-4　接岸時支持力算定結果

杭の静的最大軸方向押込み抵抗力及び静的最大引抜き抵抗力

1.杭諸元

杭径(mm)	肉厚(mm)	斜角(°)	腐食代(mm)
900	14	15	0

2.先端抵抗力R_{pk}

$R_{pk}=300NAp\alpha$

$R_{pk}=6CpAp\alpha$

N	Cp	A_p (m^2)	閉塞率(α)	R_{pk} (kN)
50		0.636	0.400	3,817.0

3.周面抵抗力R_{fk}

$R_{fk}=\Sigma r_{fki}A_{si}$

$r_{fki}=2N$

$r_{fki}=C_a$

No.	上端 (m)	下端 (m)	層厚 li (m)	層厚 li/cos θ (m)	A_s (m^2)	N	C (kN/m^2)	$2NA_s$ (kN)	C_aA_s (kN)
①	-21.60	-38.40	16.80	17.39	49.177		25.0	0.0	1,229.4
②	-38.40	-40.40	2.00	2.07	5.854	16.0		187.3	0.0
③	-40.40	-42.40	2.00	2.07	5.854	50.0		585.4	0.0
④									
⑤									
⑥									
⑦									
⑧									
⑨									
⑩									
R_{fk}, R_{tk}								2,002.2	

4.静的最大軸方向押込み抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_{c'})\times(R_{pk}+R_{fk})$						$\gamma_a \cdot R_{td}$
0.66	1.0	× (	3,817.0	+	2,002.2	)= 5,819.2	3,840.7

5.静的最大引抜き抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_{c'})\times R_{fk}$					$\gamma_a \cdot R_{td}$
0.40	1.0	×	2,002.2	=	2,002.2	800.9

表 5-46　BH-4　地震時支持力算定結果

杭の静的最大軸方向押込み抵抗力及び静的最大引抜き抵抗力

1.杭諸元

杭径(mm)	肉厚(mm)	斜角(°)	腐食代(mm)
900	14	15	0

2.先端抵抗力R_{pk}

$R_{pk}=300NAp\alpha$

$R_{pk}=6CpAp\alpha$

N	Cp	A_p (m^2)	閉塞率(α)	R_{pk} (kN)
50		0.636	0.400	3,817.0

3.周面抵抗力R_{fk}

$R_{fk}=\Sigma r_{fki}A_{si}$

$r_{fki}=2N$

$r_{fki}=C_a$

No.	上端 (m)	下端 (m)	層厚 li (m)	層厚 li/cos θ (m)	A_s (m^2)	N	C (kN/m^2)	$2NA_s$ (kN)	C_aA_s (kN)
①	-21.60	-38.40	16.80	17.39	49.177		25.0	0.0	1,229.4
②	-38.40	-40.40	2.00	2.07	5.854	16.0		187.3	0.0
③	-40.40	-42.40	2.00	2.07	5.854	50.0		585.4	0.0
④									
⑤									
⑥									
⑦									
⑧									
⑨									
⑩									
R_{fk}, R_{tk}								2,002.2	

4.静的最大軸方向押込み抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_{c'})\times(R_{pk}+R_{fk})$						$\gamma_a \cdot R_{td}$
0.66	1.0	× (	3,817.0	+	2,002.2	)= 5,819.2	3,840.7

5.静的最大引抜き抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_{c'})\times R_{fk}$					$\gamma_a \cdot R_{td}$
0.40	1.0	×	2,002.2	=	2,002.2	800.9

5-3-2　プラットホーム

5-3-2-1 鋼管杭部

表 5-47(1/4)　耐力照査(BH-2、法線直角方向地震時)

三次元杭基礎の設計

PL BH2 法線直角方向地震時 (1/4)

1. 入力条件

Ship

Xo=	3,453.000	kN
Yo=	23,018.000	kN
Zo=	0.000	kN
Mx=	0.000	kN-m
My=	0.000	kN-m
Mz=	0.000	kN-m
杭本数 n=	30	
Kh=	18.000	N/cm^3
有効座屈長	h	

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	5.250	0.000	25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
2	0.500	0.000	25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
3	-4.250	0.000	25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
4	5.250	0.000	20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
5	0.500	0.000	20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
6	-4.250	0.000	20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
7	5.250	0.000	14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
8	0.500	0.000	14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
9	-4.250	0.000	14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
10	5.250	0.000	9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
11	0.500	0.000	9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
12	-4.250	0.000	9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
13	5.250	0.000	3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
14	0.500	0.000	3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
15	-4.250	0.000	3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
16	5.250	0.000	-3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
17	0.500	0.000	-3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
18	-4.250	0.000	-3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
19	5.250	0.000	-9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
20	0.500	0.000	-9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
21	-4.250	0.000	-9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
22	5.250	0.000	-14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
23	0.500	0.000	-14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
24	-4.250	0.000	-14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
25	5.250	0.000	-20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
26	0.500	0.000	-20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
27	-4.250	0.000	-20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
28	5.250	0.000	-25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
29	0.500	0.000	-25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
30	-4.250	0.000	-25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000

2. バネ定数

PL BH2 法線直角方向地震時 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
2	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
3	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
4	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
5	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
6	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
7	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
8	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
9	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
10	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
11	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
12	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
13	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
14	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
15	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
16	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
17	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
18	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
19	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
20	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
21	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
22	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
23	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
24	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
25	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
26	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
27	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
28	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
29	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
30	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10

表 5-47(3/4)　耐力照査(BH-2、法線直角方向地震時)

PL BH2 法線直角方向地震時 (3/4)

3. 杭応力

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
2	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
3	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
4	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
5	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
6	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
7	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
8	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
9	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
10	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
11	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
12	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
13	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
14	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
15	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
16	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
17	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
18	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
19	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
20	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
21	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
22	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
23	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
24	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
25	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
26	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
27	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235
28	84.843	868.529	0.000	0.000	0.000	-576.619	576.619	37.37	32	109	208	235
29	119.110	765.612	0.000	0.000	0.000	-721.325	721.325	31.98	28	137	216	235
30	141.347	667.658	0.000	0.000	0.000	-807.093	807.093	29.47	25	153	219	235

4. 杭の応力判定及び変位量

PL BH2 法線直角方向地震時 (4/4)

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
2	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
3	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
4	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
5	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
6	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
7	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
8	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
9	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
10	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
11	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
12	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
13	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
14	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
15	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
16	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
17	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
18	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
19	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
20	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
21	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
22	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
23	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
24	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
25	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
26	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
27	0.8000	0.0120	0.763	0.045160	0.004296	0.000000
28	0.8000	0.0120	0.618	0.045160	0.005557	0.000000
29	0.8000	0.0120	0.712	0.045160	0.004926	0.000000
30	0.8000	0.0120	0.763	0.045160	0.004296	0.000000

原点の変位					
x_0	(m)	0.045160	α_0	(rad)	0.000000
y_0	(m)	0.004860	β_0	(rad)	0.000000
z_0	(m)	0.000000	γ_0	(rad)	0.000133

三次元杭基礎の設計

1. 入力条件

Ship

Xo=	0.000	kN
Yo=	23,018.000	kN
Zo=	3,453.000	kN
Mx=	0.000	kN-m
My=	0.000	kN-m
Mz=	0.000	kN-m
杭本数 n=	30	
Kh=	18.000	N/cm^3
有効座屈長	h	

PL BH2 法線平行方向地震時 (1/4)

Pile No.	x (m)	y (m)	z (m)	鉛直角 (°)	平面角 (°)	杭径 (m)	肉厚 (m)	腐食代 (m)	材質	突出長 (m)	全長 (m)
1	5.250	0.000	25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
2	0.500	0.000	25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
3	-4.250	0.000	25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
4	5.250	0.000	20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
5	0.500	0.000	20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
6	-4.250	0.000	20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
7	5.250	0.000	14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
8	0.500	0.000	14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
9	-4.250	0.000	14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
10	5.250	0.000	9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
11	0.500	0.000	9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
12	-4.250	0.000	9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
13	5.250	0.000	3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
14	0.500	0.000	3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
15	-4.250	0.000	3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
16	5.250	0.000	-3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
17	0.500	0.000	-3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
18	-4.250	0.000	-3.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
19	5.250	0.000	-9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
20	0.500	0.000	-9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
21	-4.250	0.000	-9.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
22	5.250	0.000	-14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
23	0.500	0.000	-14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
24	-4.250	0.000	-14.125	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
25	5.250	0.000	-20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
26	0.500	0.000	-20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
27	-4.250	0.000	-20.000	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000
28	5.250	0.000	-25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	10.400	34.800
29	0.500	0.000	-25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.900	35.000
30	-4.250	0.000	-25.875	0.00	0.00	0.8000	0.012	0.0010	SKK400	8.200	35.000

表 5-48(1/4)　耐力照査(BH-2、法線平行方向地震時)

2. バネ定数

PL BH2 法線平行方向地震時 (2/4)

Pile No.	断面積 (cm^2)	断面係数 (cm^3)	断面2次モーメント (cm^4)	β (m^{-1})	K_{X1} (kN/m)	K_{Z1} (kN/m)	K_{X2} (kN/rad)	K_{Z2} (kN/rad)	K_{X4} (kN-m/rad)	K_{Z4} (kN-m/rad)	K_D (kN-m/rad)	K_V (kN/m)
1	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
2	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
3	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
4	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
5	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
6	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
7	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
8	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
9	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
10	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
11	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
12	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
13	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
14	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
15	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
16	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
17	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
18	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
19	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
20	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
21	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
22	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
23	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
24	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
25	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
26	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
27	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10
28	271.97	5,278	210,602	0.3041	1,917.29	1,917.29	13,122.76	13,122.76	120,587.64	120,587.64	23,669.03	156,303.26
29	271.97	5,278	210,602	0.3041	2,685.62	2,685.62	16,367.37	16,367.37	134,306.28	134,306.28	26,581.82	155,410.10
30	271.97	5,278	210,602	0.3041	3,183.67	3,183.67	18,288.38	18,288.38	141,718.28	141,718.28	28,201.41	155,410.10

表 5-48(3/4)　耐力照査(BH-2、法線平行方向地震時)

3. 杭応力

PL BH2 法線平行方向地震時 (3/4)

Pile No.	Px (kN)	Py (kN)	Pz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Me (kN-m)	l/r	σ c σ t (N/mm^2)	σ bc σ bt (N/mm^2)	σ ca σ ta (N/mm^2)	σ ba σ ta (N/mm^2)
1	-1.802	715.826	85.433	584.227	-0.966	7.283	584.273	37.37	26	111	208	235
2	-2.855	832.948	119.182	725.772	-1.085	11.727	725.867	31.98	31	138	216	235
3	-3.568	954.160	140.685	807.547	-1.151	14.475	807.677	29.47	35	153	219	235
4	-1.342	700.545	85.433	584.227	-0.966	4.136	584.242	37.37	26	111	208	235
5	-2.211	817.754	119.182	725.772	-1.085	7.801	725.814	31.98	30	138	216	235
6	-2.804	938.967	140.685	807.547	-1.151	10.088	807.611	29.47	35	153	219	235
7	-0.883	685.264	85.433	584.227	-0.966	0.988	584.229	37.37	25	111	208	235
8	-1.567	802.561	119.182	725.772	-1.085	3.876	725.783	31.98	30	138	216	235
9	-2.041	923.773	140.685	807.547	-1.151	5.702	807.568	29.47	34	153	219	235
10	-0.491	672.259	85.433	584.227	-0.966	-1.690	584.230	37.37	25	111	208	235
11	-1.019	789.630	119.182	725.772	-1.085	0.535	725.773	31.98	29	138	216	235
12	-1.391	910.842	140.685	807.547	-1.151	1.969	807.550	29.47	33	153	219	235
13	-0.022	656.653	85.433	584.227	-0.966	-4.905	584.248	37.37	24	111	208	235
14	-0.361	774.113	119.182	725.772	-1.085	-3.474	725.781	31.98	28	138	216	235
15	-0.611	895.325	140.685	807.547	-1.151	-2.511	807.552	29.47	33	153	219	235
16	0.468	640.397	85.433	584.227	-0.966	-8.253	584.286	37.37	24	111	208	235
17	0.324	757.950	119.182	725.772	-1.085	-7.651	725.813	31.98	28	138	216	235
18	0.201	879.162	140.685	807.547	-1.151	-7.177	807.579	29.47	32	153	219	235
19	0.937	624.791	85.433	584.227	-0.966	-11.467	584.340	37.37	23	111	208	235
20	0.982	742.433	119.182	725.772	-1.085	-11.660	725.866	31.98	27	138	216	235
21	0.981	863.645	140.685	807.547	-1.151	-11.657	807.632	29.47	32	153	219	235
22	1.329	611.786	85.433	584.227	-0.966	-14.146	584.399	37.37	22	111	208	235
23	1.530	729.502	119.182	725.772	-1.085	-15.001	725.928	31.98	27	138	216	235
24	1.631	850.714	140.685	807.547	-1.151	-15.390	807.694	29.47	31	153	219	235
25	1.788	596.505	85.433	584.227	-0.966	-17.294	584.484	37.37	22	111	208	235
26	2.174	714.308	119.182	725.772	-1.085	-18.926	726.019	31.98	26	138	216	235
27	2.395	835.521	140.685	807.547	-1.151	-19.776	807.790	29.47	31	153	219	235
28	2.248	581.224	85.433	584.227	-0.966	-20.441	584.585	37.37	21	111	208	235
29	2.819	699.115	119.182	725.772	-1.085	-22.852	726.132	31.98	26	138	216	235
30	3.158	820.327	140.685	807.547	-1.151	-24.163	807.909	29.47	30	153	219	235

PL BH2 法線平行方向地震時 (4/4)

原点の変位					
x_0	(m)	-0.001008	α_0	(rad)	-0.000017
y_0	(m)	0.005011	β_0	(rad)	-0.000041
z_0	(m)	0.044459	γ_0	(rad)	-0.000164

4. 杭の応力判定及び変位量

Pile No.	杭径 (m)	肉厚 (m)	応力比	X 方向変位 (m)	Y 方向変位 (m)	Z 方向変位 (m)
1	0.8000	0.0120	0.597	-0.002064	0.004580	0.044673
2	0.8000	0.0120	0.727	-0.002064	0.005360	0.044479
3	0.8000	0.0120	0.811	-0.002064	0.006140	0.044285
4	0.8000	0.0120	0.595	-0.001824	0.004482	0.044673
5	0.8000	0.0120	0.725	-0.001824	0.005262	0.044479
6	0.8000	0.0120	0.809	-0.001824	0.006042	0.044285
7	0.8000	0.0120	0.592	-0.001584	0.004384	0.044673
8	0.8000	0.0120	0.722	-0.001584	0.005164	0.044479
9	0.8000	0.0120	0.806	-0.001584	0.005944	0.044285
10	0.8000	0.0120	0.590	-0.001380	0.004301	0.044673
11	0.8000	0.0120	0.720	-0.001380	0.005081	0.044479
12	0.8000	0.0120	0.804	-0.001380	0.005861	0.044285
13	0.8000	0.0120	0.587	-0.001135	0.004201	0.044673
14	0.8000	0.0120	0.717	-0.001135	0.004981	0.044479
15	0.8000	0.0120	0.801	-0.001135	0.005761	0.044285
16	0.8000	0.0120	0.584	-0.000880	0.004097	0.044673
17	0.8000	0.0120	0.714	-0.000880	0.004877	0.044479
18	0.8000	0.0120	0.799	-0.000880	0.005657	0.044285
19	0.8000	0.0120	0.581	-0.000635	0.003997	0.044673
20	0.8000	0.0120	0.712	-0.000635	0.004777	0.044479
21	0.8000	0.0120	0.796	-0.000635	0.005557	0.044285
22	0.8000	0.0120	0.579	-0.000431	0.003914	0.044673
23	0.8000	0.0120	0.710	-0.000431	0.004694	0.044479
24	0.8000	0.0120	0.794	-0.000431	0.005474	0.044285
25	0.8000	0.0120	0.577	-0.000191	0.003816	0.044673
26	0.8000	0.0120	0.707	-0.000191	0.004596	0.044479
27	0.8000	0.0120	0.791	-0.000191	0.005376	0.044285
28	0.8000	0.0120	0.574	0.000049	0.003719	0.044673
29	0.8000	0.0120	0.705	0.000049	0.004499	0.044479
30	0.8000	0.0120	0.789	0.000049	0.005278	0.044285

表 5-49　BH-2　地震時支持力算定結果

杭の静的最大軸方向押込み抵抗力及び静的最大引抜き抵抗力

1.杭諸元

杭径(mm)	肉厚(mm)	斜角(°)	腐食代(mm)
800	12	0	0

2.先端抵抗力R_{pk}

$R_{pk}=300NAp\alpha$

$R_{pk}=6CpAp\alpha$

N	Cp	A_p (m^2)	閉塞率(α)	R_{pk} (kN)
	78	0.503	0.000	0.0

3.周面抵抗力R_{fk}

$R_{fk}=\Sigma r_{fki}A_{si}$

$r_{fki}=2N$

$r_{fki}=C_a$

No.	上端 (m)	下端 (m)	層厚 li (m)	層厚 li/cos θ (m)	A_s (m^2)	N	C (kN/m^2)	$2NA_s$ (kN)	C_aA_s (kN)
①	-7.61	-13.10	5.49	5.49	13.798	12.0		331.1	0.0
②	-13.10	-17.30	4.20	4.20	10.556		45.0	0.0	475.0
③	-17.30	-22.70	5.40	5.40	13.572	17.0		461.4	0.0
④	-22.70	-28.00	5.30	5.30	13.320		77.5	0.0	1,032.3
⑤									
⑥									
⑦									
⑧									
⑨									
⑩									
R_{fk}, R_{tk}								2,299.9	

4.静的最大軸方向押込み抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_c)\times(R_{pk}+R_{fk})$						$\gamma_a \cdot R_{td}$
0.50	1.0	× (	0.0	+	2,299.9	)= 2,299.9	1,150.0

5.静的最大引抜き抵抗力

γ_a	$R_{td}=(\gamma_N,\gamma_c)\times R_{fk}$					$\gamma_a \cdot R_{td}$
0.40	1.0	×	2,299.9	=	2,299.9	920.0

5-3-2-2 PHC 杭部

5-3-2-2-1　　設計条件

(1)　一般事項

・データファイル名：PL PHC.F8F
・タイトル　　：プラットホーム

(2)　杭の条件

・杭種　　：PHC杭　（スパイラル鉄筋を考慮する）
・施工工法　　：打込み杭（打撃）
・杭頭接合条件　　：剛結・ヒンジ
・杭先端条件　　：ヒンジ
・杭の種類　　：摩擦杭
・杭の許容変位量　常　時　：　50.0（mm）
　　地震時　：　100.0（mm）
・杭体のヤング係数　　：　4.00 ×10^4（N/mm^2）
・杭本数　　：　50（本）
・杭径　　：　800.0（mm）
・厚さ　　：　110.0（mm）
・設計杭長，種類　　：　31.00（m）　　C種

(3)　適用基準及び参考文献

・道路橋示方書Ⅰ共通編（平成24年3月）
・道路橋示方書Ⅲコンクリート橋編（平成24年3月）
・道路橋示方書Ⅳ下部構造編（平成24年3月）
・道路橋示方書Ⅴ耐震設計編（平成24年3月）
・杭基礎設計便覧（平成19年1月）
・道路橋の耐震設計に関する資料（平成9年3月）

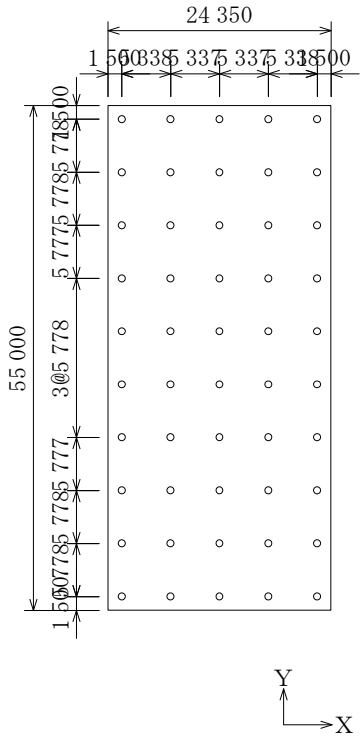
(4)　使用材料および許容応力度

設計基準強度　σ_{ck}＝80.00(N/mm^2)

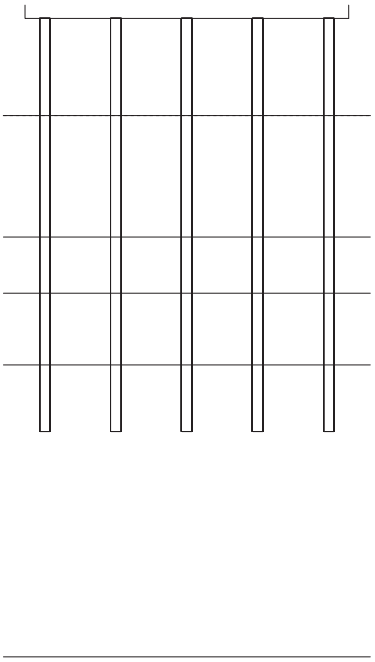
単位：N/mm^2

No	割増係数	許容曲げ圧縮応力度 σ_{ca}	許容曲げ引張応力度 σ_{ta}		許容せん断応力度 τ_a
			σ_{ce}＜7.8	σ_{ce}≧7.8	
1	1.50	40.00	3.00	5.00	1.275

(5) 杭配置図・側面図



(a)平面図



－－－ 設計地盤面(常時)
— - — 設計地盤面(地震時)
(b)側面図(橋軸直角方向)

杭頭座標(m)

X方向(橋軸直角方向)

No	1	2	3	4	5
座標	-10.675	-5.337	0.000	5.337	10.675

Y方向(橋軸方向)

No.	1	2	3	4	5	6	7	8
座標	26.000	20.222	14.444	8.667	2.889	-2.889	-8.667	-14.444

No	9	10
座標	-20.222	-26.000

※各方向の座標の向きは図中(a)に示す。

(6) 地層データ

層No	層種	層厚(m)		平均N値	α・E_o(kN/m^2)		γ(kN/m^3)		f (kN/m^2)	
		常　時	地震時		常 時	地震時	γ	γ'	f	fn
＊	――	7.300	7.300	――	――	――	――	――	――	――
1	砂質土	9.100	9.100	12.0	33,600	67,200	18.00	9.90	24.0	24.0
2	粘性土	4.200	4.200	10.0	28,000	56,000	15.00	4.90	45.0	45.0
3	砂礫土	5.400	5.400	17.0	47,600	95,200	15.00	4.90	34.0	34.0
4	粘性土	5.000	5.000	22.0	61,600	123,200	15.00	4.90	77.5	77.5

＊は突出部を表わす。

(7) ばね定数，許容支持力・引抜力，断面二次モーメント

・杭軸方向ばね定数　Kv(kN/m)

常　時	456,671
地震時	456,671

・許容支持力・引抜力　(kN/本)

許容支持力	常　時	756
	地震時	1,152
許容引抜力	常　時	528
	地震時	938

・水平方向地盤反力係数　k_H(kN/m^3)

層No	層厚(m)		橋軸直角方向		橋軸方向	
	常　時	地震時	常　時	地震時	常　時	地震時
突出部	7.300	7.300	―――	―――	―――	―――
1	9.100	9.100	32,377	64,754	32,377	64,754
2	4.200	4.200	26,981	53,962	26,981	53,962
3	5.400	5.400	45,868	91,735	45,868	91,735
4	5.000	5.000	59,358	118,716	59,358	118,716

・杭体断面二次モーメント　I(m^4)

第1断面	0.014551221

※断面の取扱い：総断面

(8) 作用力

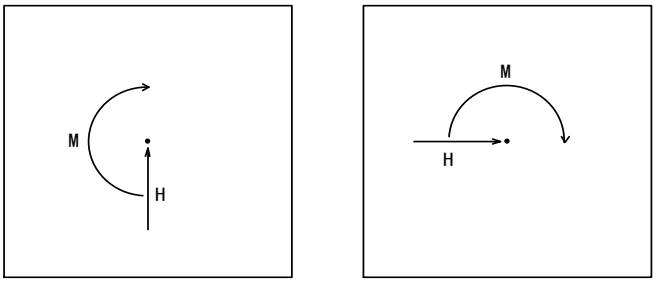
(a)　橋軸直角方向

No	荷重ケース名称	割増係数	鉛直力 V(kN)	水平力 H(kN)	モーメント M(kN.m)
1	地震時	1.50	41,517.00	6,228.00	0.00

(b)　橋軸方向

No	荷重ケース名称	割増係数	鉛直力 V(kN)	水平力 H(kN)	モーメント M(kN.m)
1	地震時	1.50	41,517.00	6,228.00	0.00

橋軸方向　　橋軸直角方向



5-3-2-2-2　　安定計算

(1)　杭軸直角方向ばね定数

橋軸直角方向

杭頭剛結

	単位	常　時	地震時
K1	kN/m	5,936	6,972
K2	kN/rad	30,807	34,472
K3	kN.m/m	30,807	34,472
K4	kN.m/rad	215,956	229,308

橋軸方向

杭頭剛結

	単位	常　時	地震時
K1	kN/m	5,936	6,972
K2	kN/rad	30,807	34,472
K3	kN.m/m	30,807	34,472
K4	kN.m/rad	215,956	229,308

(2)　杭基礎の剛性行列

1.変位法による底版中心の変位と外力の関係

$$\begin{bmatrix} V \\ H \\ M \end{bmatrix} = \begin{bmatrix} Azz & Azx & Aza \\ Axz & Axx & Axa \\ Aaz & Aax & Aaa \end{bmatrix} \begin{bmatrix} \delta z \\ \delta x \\ \alpha \end{bmatrix}$$

2.剛性行列要素

A_{zz}　　$=\Sigma\ (K_v \cdot \cos^2\theta + K1 \cdot \sin^2\theta)\ i$

$A_{zx}=A_{xz}=\Sigma\ (K_v \cdot \cos\theta \cdot \sin\theta - K1 \cdot \sin\theta \cdot \cos\theta)\ i$

$A_{za}=A_{az}=\Sigma\ (K_v \cdot X \cdot \cos^2\theta + K1 \cdot X \cdot \sin^2\theta + K2 \cdot \sin\theta)\ i$

A_{xx}　　$=\Sigma\ (K_v \cdot \sin^2\theta + K1 \cdot \cos^2\theta)\ i$

$A_{xa}=A_{ax}=\Sigma\ (K_v \cdot X \cdot \sin\theta \cdot \cos\theta - K1 \cdot X \cdot \sin\theta \cdot \cos\theta - K2 \cdot \cos\theta)\ i$

A_{aa}　　$=\Sigma\ \{K_v \cdot X^2 \cdot \cos^2\theta + K1 \cdot X^2 \cdot \sin^2\theta + (K2+K3) \cdot X \cdot \sin\theta + K4\}\ i$

ここに、A_{zz}　　：鉛直方向ばね(kN/m)

$A_{zx}=A_{xz}$：鉛直と水平の連成ばね(kN/m)

$A_{za}=A_{az}$：鉛直と回転の連成ばね(kN/rad, kN.m/m)
A_{xx}　　：水平方向ばね(kN/m)
$A_{xa}=A_{ax}$：水平と回転の連成ばね(kN/rad, kN.m/m)
A_{aa}　　：回転ばね(kN.m/rad)
V　　：原点に作用する鉛直力(kN)
H　　：原点に作用する水平力(kN)
M　　：原点に作用するモーメント(kN.m)
K_{vi}　　：杭軸方向ばね定数(kN/m)
$K1_i$～$K4_i$：杭軸直角方向ばね定数(kN/m,kN/rad,kN.m/m,kN.m/rad)
X_i　　：杭頭の水平座標(m)
θ_i　　：杭軸が鉛直軸となす角度(rad)
δ_z　　：原点鉛直変位(m)
δ_x　　：原点水平変位(m)
α　　：原点回転角(rad)

注）式中のiはi番目の杭を示す。

(a)　橋軸直角方向

杭頭剛結

常時

$$\begin{bmatrix} Azz & Azx & Aza \\ Axz & Axx & Axa \\ Aaz & Aax & Aaa \end{bmatrix} = \begin{bmatrix} 22833550 & 0 & 0 \\ 0 & 296801 & -1540329 \\ 0 & -1540329 & 1311754814 \end{bmatrix}$$

地震時

$$\begin{bmatrix} Azz & Azx & Aza \\ Axz & Axx & Axa \\ Aaz & Aax & Aaa \end{bmatrix} = \begin{bmatrix} 22833550 & 0 & 0 \\ 0 & 348583 & -1723608 \\ 0 & -1723608 & 1312422418 \end{bmatrix}$$

(b)　橋軸方向

杭頭剛結

常時

$$\begin{bmatrix} Azz & Azx & Aza \\ Axz & Axx & Axa \\ Aaz & Aax & Aaa \end{bmatrix} = \begin{bmatrix} 22833550 & 0 & 0 \\ 0 & 296801 & -1540329 \\ 0 & -1540329 & 6299256291 \end{bmatrix}$$

地震時

$$\begin{bmatrix} Azz & Azx & Aza \\ Axz & Axx & Axa \\ Aaz & Aax & Aaa \end{bmatrix} = \begin{bmatrix} 22833550 & 0 & 0 \\ 0 & 348583 & -1723608 \\ 0 & -1723608 & 6299923895 \end{bmatrix}$$

(3) 杭反力及び変位の計算

$$\begin{bmatrix} PN \\ PH \\ Mt \end{bmatrix}_i = \begin{bmatrix} Kv\cdot\cos\theta & Kv\cdot\sin\theta & Kv\cdot X\cdot\cos\theta \\ -K1\cdot\sin\theta & K1\cdot\cos\theta & -K1\cdot X\cdot\sin\theta - K2 \\ K3\cdot\sin\theta & -K3\cdot\cos\theta & K3\cdot X\cdot\sin\theta + K4 \end{bmatrix}_i \begin{bmatrix} \delta z \\ \delta x \\ \alpha \end{bmatrix}_o$$

$\delta zi = (\delta z + \alpha \cdot Xi)\cdot\cos\theta i + \delta x \cdot \sin\theta i$

$\delta xi = -(\delta z + \alpha \cdot Xi)\cdot\sin\theta i + \delta x \cdot \cos\theta i$

ここに、 PN_i：杭軸方向反力(kN/本)

PH_i：杭軸直角方向反力(kN/本)

Mt_i：杭頭モーメント(kN.m/本)

K_{vi}：杭軸方向ばね定数(kN/m)

K1i～$K4_i$：杭軸直角方向ばね定数(kN/m,kN/rad,kN.m/m,kN.m/rad)

X_i ：杭頭座標(m)

θ_i：杭軸が鉛直軸となす角度(rad)

δ_z：原点鉛直変位(m)

δ_x：原点水平変位(m)

α ：原点回転角(rad)

δz_i：杭頭の杭軸方向変位(m)

δx_i：杭頭の杭軸直角方向変位(m)

杭頭での鉛直反力V_i，及び水平反力H_iは、次式による。

$V_i = PN_i \cdot \cos\theta_i - PH_i \cdot \sin\theta_i$

$H_i = PN_i \cdot \sin\theta_i + PH_i \cdot \cos\theta_i$

注）式中のiはi番目の杭を示す。

(a) 橋軸直角方向

杭頭剛結

地震時

・原点作用力

V_o = 41,517.00 (kN)

H_o = 6,228.00 (kN)

M_o = 0.00 (kN.m)

・原点変位

δ_z = 1.82 (mm)

δ_x = 17.98 (mm)

α = 0.00002362 (rad)

・杭反力

No	X(m)	本数	PN(kN)	PH(kN)	M_t(kN.m)	V_i(kN)	H_i(kN)	δf_x(mm)
1	-10.675	10	715.20	124.56	-614.51	715.20	124.56	3.56
2	-5.337	10	772.78	124.56	-614.51	772.78	124.56	3.56
3	0.000	10	830.34	124.56	-614.51	830.34	124.56	3.56
4	5.337	10	887.90	124.56	-614.51	887.90	124.56	3.56
5	10.675	10	945.48	124.56	-614.51	945.48	124.56	3.56

PN_{max} = 945.48 (kN) ≦ R_a = 1,152.00 (kN) : OK

PN_{min} = 715.20 (kN) ≧ P_a = -938.00 (kN) : OK

δ_f = 3.56 (mm) ≦ δ_a = 100.00 (mm) : OK

(b)　橋軸方向

杭頭剛結

地震時

・原点作用力

V_o = 41,517.00 (kN)

H_o = 6,228.00 (kN)

M_o = 0.00 (kN.m)

・原点変位

δ_z = 1.82 (mm)

δ_x = 17.89 (mm)

α = 0.00000489 (rad)

・杭反力

No	Y(m)	本数	PN(kN)	PH(kN)	M_t(kN.m)	V_i(kN)	H_i(kN)	δf_x(mm)
1	26.000	5	888.46	124.56	-615.61	888.46	124.56	3.55
2	20.222	5	875.54	124.56	-615.61	875.54	124.56	3.55
3	14.444	5	862.63	124.56	-615.61	862.63	124.56	3.55
4	8.667	5	849.71	124.56	-615.61	849.71	124.56	3.55
5	2.889	5	836.80	124.56	-615.61	836.80	124.56	3.55
6	-2.889	5	823.88	124.56	-615.61	823.88	124.56	3.55
7	-8.667	5	810.97	124.56	-615.61	810.97	124.56	3.55
8	-14.444	5	798.05	124.56	-615.61	798.05	124.56	3.55
9	-20.222	5	785.14	124.56	-615.61	785.14	124.56	3.55
10	-26.000	5	772.22	124.56	-615.61	772.22	124.56	3.55

PN_{max} = 888.46 (kN) ≦ R_a = 1,152.00 (kN) : OK

PN_{min} = 772.22 (kN) ≧ P_a = -938.00 (kN) : OK

δ_f = 3.55 (mm) ≦ δ_a = 100.00 (mm) : OK

5-3-2-2-3　　断面計算

(1)　杭体断面力

表 5-50　杭体断面力(橋軸直角方向　地震時)

	杭頭剛結			杭頭ヒンジ		
杭頭作用力 H (kN) M (kN.m)		124.56 -614.51			124.56 0.00	
杭軸直角方向ばね定数 K1(kN/m) K2(kN/rad) K3(kN.m/m) K4(kN.m/rad)		6,972 34,472 34,472 229,308			1,789 0 0 0	
M_t (kN.m) M_{max} (kN.m) Z (m) $1/2M_{max}$(kN.m) S (kN)		-614.51 344.32 8.181 466.14 124.56			0.00 932.28 7.688 466.14 -221.84	
Z (m)	δx(mm)	M (kN.m)	S (kN)	δx(mm)	M (kN.m)	S (kN)
0.000	17.983	-614.51	124.56	69.609	0.00	124.56
0.500	17.844	-552.23	124.56	64.381	62.28	124.56
1.000	17.468	-489.95	124.56	59.180	124.56	124.56
1.500	16.881	-427.67	124.56	54.033	186.84	124.56
2.000	16.110	-365.39	124.56	48.965	249.12	124.56
2.500	15.182	-303.11	124.56	44.005	311.40	124.56
3.000	14.125	-240.83	124.56	39.179	373.68	124.56
4.000	11.725	-116.27	124.56	30.034	498.24	124.56
5.000	9.127	8.29	124.56	21.745	622.80	124.56
6.000	6.542	132.85	124.56	14.527	747.36	124.56
7.000	4.185	257.41	124.56	8.592	871.92	124.56
7.300	3.555	294.78	124.56	7.094	909.29	124.56
8.000	2.268	342.58	19.80	4.150	919.73	-76.94
9.000	0.923	316.50	-60.36	1.257	763.47	-210.63
10.000	0.114	240.27	-85.15	-0.335	536.48	-229.67
11.000	-0.282	156.32	-79.34	-1.002	322.84	-191.90
12.000	-0.408	85.83	-60.57	-1.107	158.69	-135.54
13.000	-0.384	35.85	-39.61	-0.931	50.68	-82.02
14.000	-0.295	5.50	-21.87	-0.662	-9.47	-40.63
15.000	-0.195	-9.60	-9.20	-0.403	-35.29	-13.23
16.000	-0.110	-14.53	-1.41	-0.203	-39.94	2.19
16.400	-0.082	-14.68	0.57	-0.142	-38.31	5.74
17.000	-0.048	-13.80	2.24	-0.069	-33.97	8.43
18.000	-0.011	-10.83	3.43	0.006	-24.68	9.61
19.000	0.009	-7.34	3.41	0.039	-15.51	8.51
20.000	0.015	-4.18	2.85	0.045	-7.93	6.61
20.600	0.016	-2.59	2.45	0.042	-4.31	5.47
21.000	0.015	-1.70	2.00	0.038	-2.36	4.29
22.000	0.011	-0.20	1.05	0.026	0.69	1.96

※M_{max}:地中部最大モーメント, $1/2M_{max} = 1/2 \cdot \max(M_{max}, M_t)$,　M_t:杭頭モーメント

表 5-51　杭体断面力(橋軸方向　地震時)

	杭頭剛結			杭頭ヒンジ		
杭頭作用力 H (kN) M (kN.m)	124.56 -615.61			124.56 0.00		
杭軸直角方向ばね定数 K1(kN/m) K2(kN/rad) K3(kN.m/m) K4(kN.m/rad)	6,972 34,472 34,472 229,308			1,789 0 0 0		
M_t (kN.m) M_{max} (kN.m) Z (m) $1/2M_{max}$(kN.m) S (kN)	-615.61 343.32 8.182 466.14 124.56			0.00 932.28 7.688 466.14 -221.84		
Z (m)	δx(mm)	M (kN.m)	S (kN)	δx(mm)	M (kN.m)	S (kN)
0.000	17.891	-615.61	124.56	69.609	0.00	124.56
0.500	17.761	-553.33	124.56	64.381	62.28	124.56
1.000	17.393	-491.05	124.56	59.180	124.56	124.56
1.500	16.814	-428.77	124.56	54.033	186.84	124.56
2.000	16.051	-366.49	124.56	48.965	249.12	124.56
2.500	15.131	-304.21	124.56	44.005	311.40	124.56
3.000	14.080	-241.93	124.56	39.179	373.68	124.56
4.000	11.693	-117.37	124.56	30.034	498.24	124.56
5.000	9.104	7.19	124.56	21.745	622.80	124.56
6.000	6.528	131.75	124.56	14.527	747.36	124.56
7.000	4.178	256.31	124.56	8.592	871.92	124.56
7.300	3.549	293.68	124.56	7.094	909.29	124.56
8.000	2.265	341.55	19.98	4.150	919.73	-76.94
9.000	0.922	315.70	-60.09	1.257	763.47	-210.63
10.000	0.115	239.73	-84.89	-0.335	536.48	-229.67
11.000	-0.281	156.02	-79.14	-1.002	322.84	-191.90
12.000	-0.407	85.70	-60.43	-1.107	158.69	-135.54
13.000	-0.383	35.83	-39.53	-0.931	50.68	-82.02
14.000	-0.295	5.53	-21.84	-0.662	-9.47	-40.63
15.000	-0.195	-9.55	-9.19	-0.403	-35.29	-13.23
16.000	-0.109	-14.49	-1.42	-0.203	-39.94	2.19
16.400	-0.082	-14.64	0.56	-0.142	-38.31	5.74
17.000	-0.048	-13.76	2.23	-0.069	-33.97	8.43
18.000	-0.011	-10.80	3.42	0.006	-24.68	9.61
19.000	0.009	-7.32	3.40	0.039	-15.51	8.51
20.000	0.015	-4.17	2.85	0.045	-7.93	6.61
20.600	0.016	-2.58	2.44	0.042	-4.31	5.47
21.000	0.015	-1.70	2.00	0.038	-2.36	4.29
22.000	0.011	-0.20	1.04	0.026	0.69	1.96

※M_{max}:地中部最大モーメント, $1/2M_{max} = 1/2 \cdot \max(M_{max}, M_t)$,　M_t:杭頭モーメント

(2)　断面力図

橋軸直角方向　　地震時

杭　径　D =　800.0 (mm)

杭　長　L =　31.00 (m)

【杭頭剛結】

H　=　124.56 (kN)　M　=　-614.51 (kN.m)

【杭頭ヒンジ】

H　=　124.56 (kN)

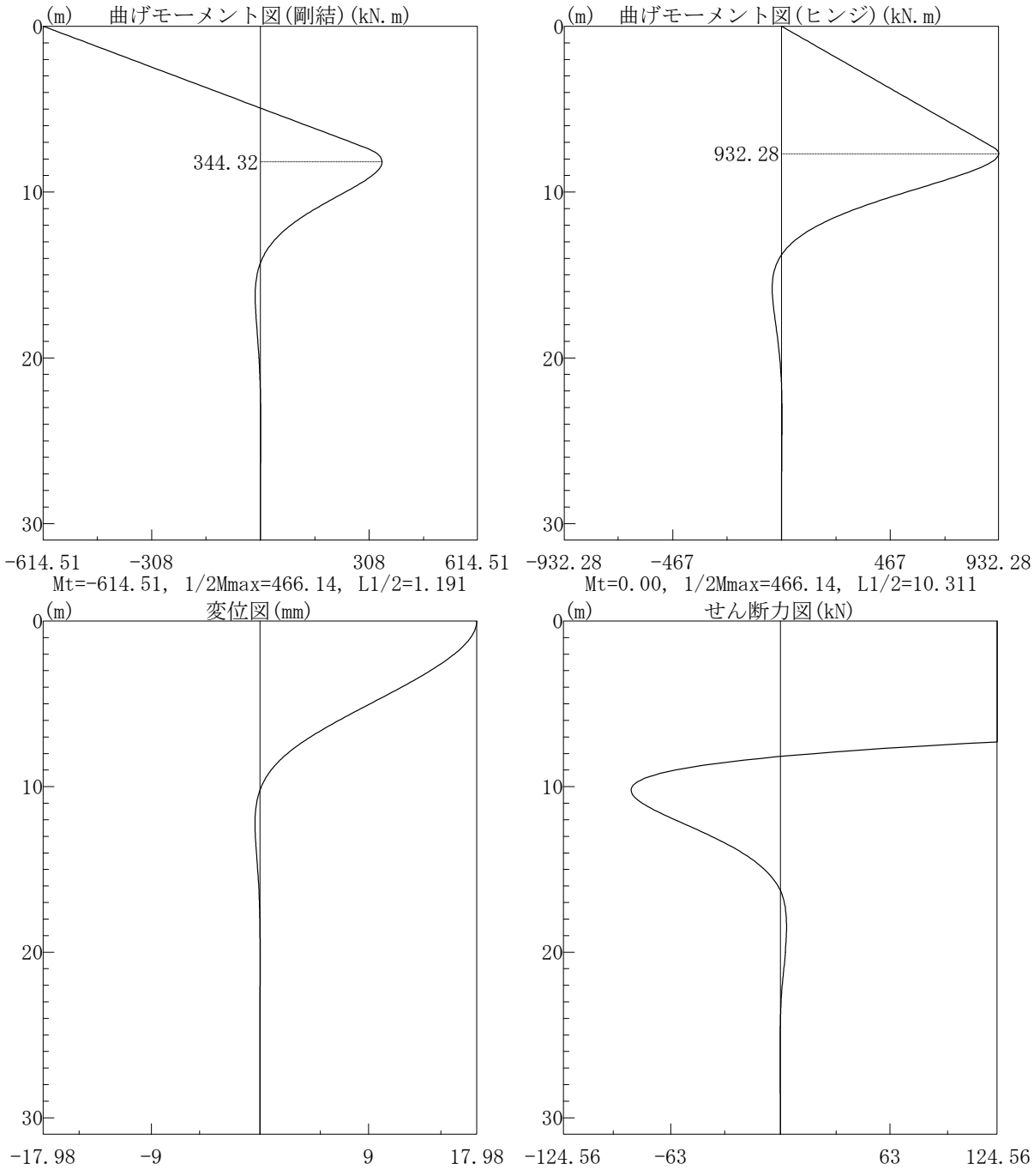


図 5-49　断面力図(橋軸直角方向、地震時)

2) 橋軸方向　地震時

杭　径　D =　800.0 (mm)

杭　長　L =　31.00 (m)

【杭頭剛結】

H　=　124.56 (kN)　M　=　-615.61 (kN.m)

【杭頭ヒンジ】

H　=　124.56 (kN)

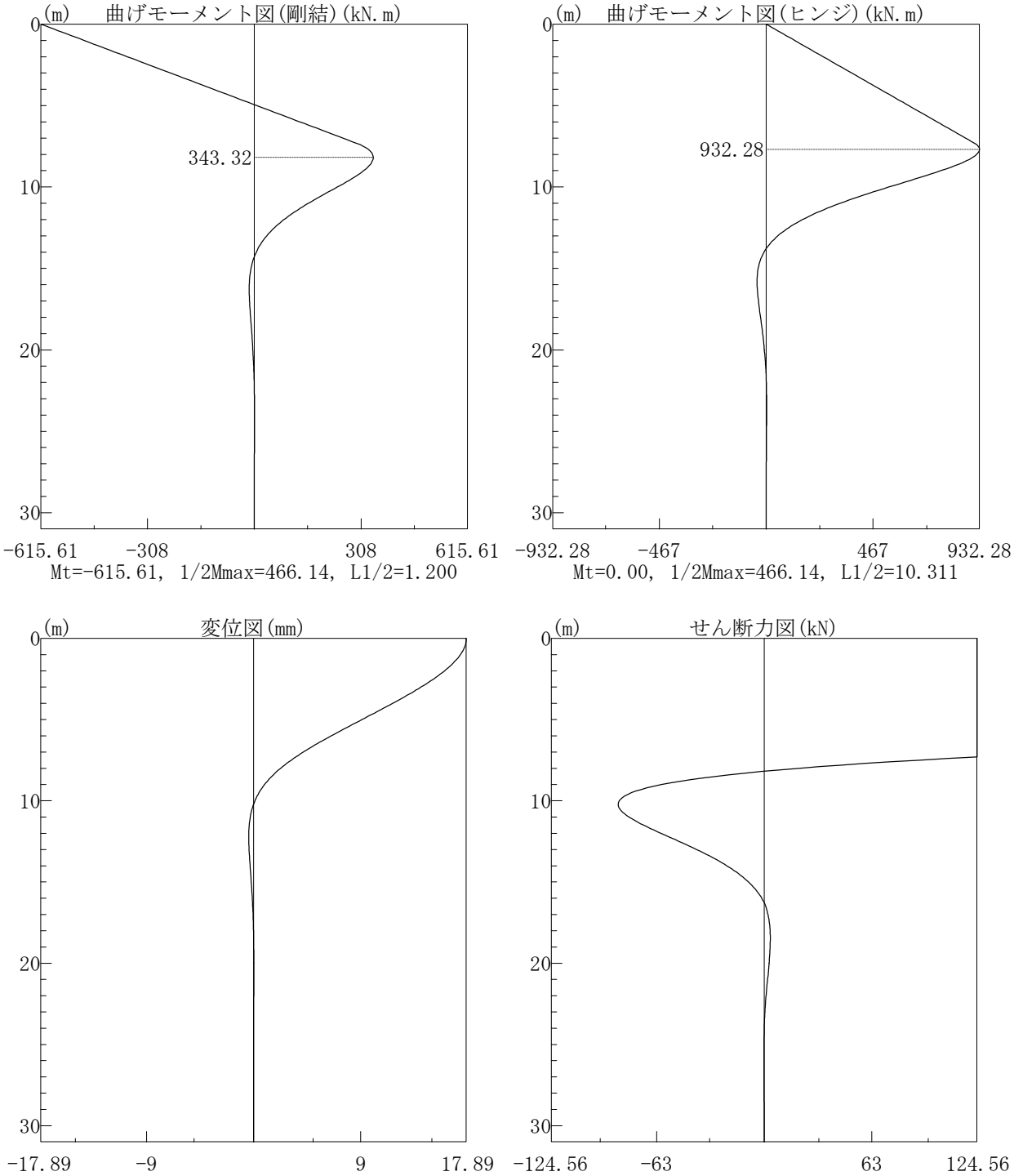


図 5-50　断面力図(橋軸方向、地震時)

(3) 杭体応力度

PHC杭

第1断面

杭外径　D =　800.0(mm)　　厚さ　t = 110.0(mm)

種別　　C種

有効プレストレス　σ_{ce} =　　10.000(N/mm^2)

換算断面積　　A_e =　2512.00 ×10^2(mm^2)

換算断面係数　　Z_e = 38,340.00 ×10^3(mm^3)

曲げ応力度の照査

$$\sigma = \sigma ce + \frac{N}{Ae} \pm \frac{M}{Ze}$$

(a)橋軸直角方向

No	荷重名略称	着目杭 行	着目杭 列	M (kN.m)	N (kN)	σ_c,σ_{ca} (N/mm^2)	σ_t,σ_{ta} (N/mm^2)	M_r(kN.m) M_r_L(m)
1	地震時	1	5	614.51	945.48	29.79 40.00	-2.26 -5.00	719.41 ――
		1	1	614.51	715.20	28.88 40.00	-3.18 -5.00	684.26 ――

上段がN_{max}，下段がN_{min}を示す。M_r_LはM_rと実モーメントとの交点深度を示す。

(b)橋軸方向

No	荷重名略称	着目杭 行	着目杭 列	M (kN.m)	N (kN)	σ_c,σ_{ca} (N/mm^2)	σ_t,σ_{ta} (N/mm^2)	M_r(kN.m) M_r_L(m)
1	地震時	1	1	615.61	888.46	29.59 40.00	-2.52 -5.00	710.70 ――
		10	1	615.61	772.22	29.13 40.00	-2.98 -5.00	692.96 ――

上段がN_{max}，下段がN_{min}を示す。M_r_LはM_rと実モーメントとの交点深度を示す。

せん断応力度の照査

コンクリートのみでせん断力を負担する場合

$$\tau = \frac{S}{b \cdot d} \leqq \tau a$$

$\tau a = CN \cdot \tau_{a1}$

ここに、

S　　：せん断力(kN)

b　　：部材断面幅（等積箱形断面の腹部の合計幅とする）　b =　195 (mm)

d　　：部材断面の有効高（等積箱形断面の有効高とする）　d =　710 (mm)

r_s　：部材軸方向鉄筋の配置半径　　r_s =　395.0 (mm)

τ_a　：軸方向圧縮力により割増しされた許容せん断応力度 (N/mm^2)

τ_{a1}：コンクリートのみでせん断力を負担する場合の許容せん断応力度 (N/mm^2)

CN　：軸方向圧縮力による補正係数

$$CN = 1 + \frac{Mo}{M}$$　　ただし，1≦CN≦2

M_o ：軸方向圧縮力によりコンクリートの応力度が部材引張縁で零となる曲げモーメント(kN.m)

$$Mo = \left(\sigma ce + \frac{N}{Ac} \right) \cdot \frac{Ic}{y}$$

N ：部材断面に作用する軸方向圧縮力(kN)

σ_{ce}：有効プレストレス $\sigma_{ce} = 10.00$ (N/mm^2)

A_c ：部材断面積 $A_c = 2{,}384.4689 \times 10^2$ (mm^2)

I_c ：部材断面の図心軸に関する断面二次モーメント $I_c = 1{,}455{,}122.1741 \times 10^4$ (mm^4)

y ：部材断面の図心より部材引張縁までの距離 y = 400 (mm)

斜引張鉄筋（スパイラル鉄筋）と共同してせん断力を負担する場合

$P_s = S_c + S_s$

$S_c = \tau_{a1} \cdot CN \cdot b \cdot d$

$$Ss = \frac{Aw \cdot \sigma sa \cdot d \cdot (\sin\theta + \cos\theta)}{1.15 \cdot s}$$

$S \leqq P_s$

ここに、

P_s ：許容せん断力 (kN)

S_c ：コンクリートの負担するせん断力 (kN)

S_s ：斜引張鉄筋の負担するせん断力 (kN)

τ_{a1}：コンクリートのみでせん断力を負担する場合の許容せん断応力度 (N/mm^2)

b ：部材断面幅（等積箱形断面の腹部の合計幅とする）(mm)

d ：部材断面の有効高（等積箱形断面の有効高とする）(mm)

A_w ：間隔sおよび角度θで配筋される斜引張鉄筋の断面積 $A_w = 0.000 \times 10^2$ (mm^2)

σ_{sa}：斜引張鉄筋の許容引張応力度 $\sigma_{sa} = 50.00$ (N/mm^2)

〃 （地震時の基本値） $\sigma_{sa} = 50.00$ (N/mm^2)

s ：斜引張鉄筋の部材軸方向の間隔 (mm) s = 80 (mm)

θ ：斜引張鉄筋が部材軸方向となす角度（90°とする）

(a) 橋軸直角方向

No	荷重名略称	着目杭 行	着目杭 列	M (kN.m)	N (kN)	M_o(kN.m) CN	S_c (kN) S_s (kN)	τ (N/mm^2) τ_a(N/mm^2)	S (kN) P_s (kN)
1	地震時	1	5	614.51	945.48	508.02 1.827	322.46 0.00	0.900 2.329	124.56 322.46
		1	1	614.51	715.20	472.89 1.770	312.37 0.00	0.900 2.256	124.56 312.37

上段がN_{max}，下段がN_{min}を示す。

(b) 橋軸方向

No	荷重名略称	着目杭 行	着目杭 列	M (kN.m)	N (kN)	M_o(kN.m) CN	S_c (kN) S_s (kN)	τ (N/mm^2) τ_a(N/mm^2)	S (kN) P_s (kN)
1	地震時	1	1	615.61	888.46	499.33 1.811	319.71 0.00	0.900 2.309	124.56 319.71
		10	1	615.61	772.22	481.59 1.782	314.62 0.00	0.900 2.272	124.56 314.62

上段がN_{max}，下段がN_{min}を示す。

5-3-2-2-4　　基礎杭計算結果一覧表

(1)　橋軸直角方向

表 5-52　基礎杭計算結果一覧表(橋軸直角方向)

荷重ケースNo. 略称			1 地震時
原点作用力			
Vo Ho Mo		kN kN kN.m	41,517.0 6,228.0 0.0
原点変位			
δ_x δ_z α		mm mm rad	17.98 1.82 0.00002362
δ_f, δ_a 抽出杭番号		mm 行,列	3.56 ≦ 100.00 (1, 1)
鉛直反力			
PN_{max}, R_a 抽出杭番号 PN_{min}, P_a 抽出杭番号		kN 行,列 kN 行,列	945.48≦ 1,152.00 (1, 5) 715.20≧ -938.00 (1, 1)
水平反力			
PH 抽出杭番号		kN 行,列	124.56 (1, 1)
杭作用モーメント			
杭頭　M_t 抽出杭番号 地中部 Mm 抽出杭番号		kN.m 行,列 kN.m 行,列	-614.51 (1, 1) 932.28 (1, 1)
杭体応力度			
1 断 面	σ_c,σ_{ca} 抽出杭 σ_t,σ_{ta} 抽出杭 τ, τ_a 抽出杭 S, P_s 抽出杭	N/mm^2 行,列 N/mm^2 行,列 N/mm^2 行,列 kN 行,列	29.79≦ 40.00 (1, 5) -3.18≧ -5.00 (1, 1) 0.900≦ 2.256 (1, 1) 124.56≦ 312.37 (1, 1)
判定			OK

杭　種：打込み杭打撃工法　PHC杭
杭　径：φ =　800.0 (mm)
厚　さ：t　=　110.0 (mm)
杭　長：L　=　31.00 (m)
種　類：　　C種

(2) 橋軸方向

表 5-53　基礎杭計算結果一覧表(橋軸方向)

荷重ケースNo. 略称			1 地震時
原点作用力			
V_o H_o M_o		kN kN kN.m	41,517.0 6,228.0 0.0
原点変位			
δ_x δ_z α		mm mm rad	17.89 1.82 0.00000489
δ_f, δ_a 抽出杭番号		mm 行,列	3.55 ≦ 100.00 (1, 1)
鉛直反力			
PN_{max}, R_a 抽出杭番号 PN_{min}, P_a 抽出杭番号		kN 行,列 kN 行,列	888.46≦ 1,152.00 (1, 1) 772.22≧ -938.00 (10, 1)
水平反力			
PH 抽出杭番号		kN 行,列	124.56 (1, 1)
杭作用モーメント			
杭頭　M_t 抽出杭番号 地中部 M_m 抽出杭番号		kN.m 行,列 kN.m 行,列	-615.61 (1, 1) 932.28 (1, 1)
杭体応力度			
1 断 面	σ_c,σ_{ca} 抽出杭 σ_t,σ_{ta} 抽出杭 τ, τ_a 抽出杭 S, P_s 抽出杭	N/mm^2 行,列 N/mm^2 行,列 N/mm^2 行,列 kN 行,列	29.59≦ 40.00 (1, 1) -2.98≧ -5.00 (10, 1) 0.900≦ 2.272 (10, 1) 124.56≦ 314.62 (10, 1)
判定			OK

杭　種：打込み杭打撃工法　PHC杭

杭　径：φ ＝ 800.0 (mm)

厚　さ：t ＝ 110.0 (mm)

杭　長：L ＝ 31.00 (m)

種　類：　　C種

5-3-2-2-5　　予備計算

(1)　水平方向地盤反力係数

杭外径		D =	0.8000	(m)
杭体ヤング係数		E =	4.00×10^7	(kN/m^2)
杭体断面二次モーメント		I =	0.014551221	(m^4)
杭の特性値(換算載荷幅算出)	常時	β =	0.324771	(m^{-1})
	地震時	β =	0.324771	(m^{-1})
水平抵抗に関する	常時	1／β =	3.0791	(m)
地盤の深さ	地震時	1／β =	3.0791	(m)

$\frac{1}{\beta}$の範囲の平均　$\alpha \cdot Eo = \dfrac{\Sigma(\alpha \cdot Eoi \cdot Li)}{1/\beta}$ = 33600.0 (kN/m²) (常時)

= 33,600.0 (kN/m^2) (地震時)

杭の換算載荷幅　$BH = \sqrt{\dfrac{D}{\beta}}$ = 1.5695 (m)　(常時)

= 1.5695 (m)　(地震時)

$kHo = \dfrac{1}{0.3} \cdot \alpha \cdot Eo$ = 112000.0 (kN/m³) (常時)

= 112,000.0 (kN/m^3) (地震時)

$kH = kHo \cdot \left(\dfrac{BH}{0.3}\right)^{-\frac{5}{4}}$

$\beta = \sqrt[4]{\dfrac{kH \cdot D}{4 \cdot E \cdot I}}$ = 0.324771 (m^{-1}) (常時), 0.324771 (m^{-1}) (地震時)

※地震時BH算出時のα・Eoの取扱い：地震時の1／2

層No	層厚(m)		α・E_o (kN/m^2)		k_H (kN/m^3)	
	常　時	地震時	常　時	地震時	常　時	地震時
突出部	7.300	7.300	――	――	――	――
1	9.100	9.100	33,600	67,200	32,377	64,754
2	4.200	4.200	28,000	56,000	26,981	53,962
3	5.400	5.400	47,600	95,200	45,868	91,735
4	5.000	5.000	61,600	123,200	59,358	118,716

(2) 杭軸方向鉛直ばね定数

$$Kv = a \cdot \frac{Ap \cdot Ep}{L}$$

杭　種：PHC杭
工　法：打込み杭打撃工法

$a = 0.014 \cdot (L'／D) + 0.72 = 1.1348$

Ap : 杭の純断面積	=	0.23845	(m^2)
Ep : 杭体のヤング係数	=	4.00×10^7	(kN/m^2)
L : 杭長	=	23.700	(m)
L' : 杭長（補正係数a算出用）	=	23.700	(m)
D : 杭径	=	0.8000	(m)

Kv = 456,671 (kN/m)

(3) 最大周面摩擦力度

杭周面に働く最大周面摩擦力度を以下に示す。

(a) 最大周面摩擦力度の推定方法

	砂質土	粘性土
打込み杭工法	2N（≦100）	cまたは10N（≦150）

※Nは各層のN値、cは地盤の粘着力(kN/m^2)を示す。
※粘性土の最大周面摩擦力度は、N値および粘着力cから推定した結果のうち小さい方を採用する。
※N値から推定する場合、N値が5未満となる軟弱層の最大周面摩擦力度は0とする。

(b) 最大周面摩擦力度

層No	標高(m)	層厚(m)	土質	平均N値	粘着力c (kN/m^2)	f_i (kN/m^2)
1	-4.000 -13.100	9.100	砂質	12.0	0.0	24.0
2	-13.100 -17.300	4.200	粘性	10.0	45.0	45.0
3	-17.300 -22.700	5.400	砂礫	17.0	0.0	34.0
4	-22.700 -44.600	21.900	粘性	22.0	77.5	77.5

※現地盤面から全層の最大周面摩擦力度を示す。

(4) 許容支持力の計算

(a) 杭の諸元

杭　　種　　：PHC杭　φ 800.0 (mm)

工　　法　　：打込み杭（打撃）

設計杭長　　：L　= 31.000 (m)

突出杭長　　：Lo =　7.300 (m)　（現地盤面から上を示す）

杭の種類　　：摩擦杭

(b) 軸方向許容押込み支持力の計算

$$Ra = \frac{\gamma}{n} \cdot (Ru - Ws) + Ws - W$$

$R_u = U \cdot \Sigma(L_i \cdot f_i)$　　(常　時), (地震時(液無))

$R_u = U \cdot \Sigma(L_i \cdot f_i \cdot DE_i)$　(地震時(液有))

R_a：杭頭における杭の軸方向許容押込み支持力 (kN)

n　：安全率　　3.0 (常　時)

　　2.0 (地震時)

γ：安全率の補正係数 = 1.0

R_u：地盤から決まる杭の極限支持力 (kN)

U　：杭の周長(m)

$U = \pi \cdot 0.8000 = 2.513$ (m)

L_i：層厚(m)

f_i：層の最大周面摩擦力度(kN/m^2)

DE_i：土質定数の低減係数（地震時のみ）

W_s：杭で置き換えられる部分の土の有効重量(kN)

$Ws = Ap \cdot \Sigma(\gamma i \cdot Li)$

γ_i：土の有効単位重量(kN/m^3)

周面摩擦力および杭で置き換えられる部分の土の有効重量

・常　時

層 No	土質	平均 N値	粘着力 (kN/m^2)	層厚 L_i(m)	γ_i (kN/m^3)	W_s (kN)	f_i (kN/m^2)	$L_i \cdot f_i$ (kN/m)
1	砂質	12.0	0.0	9.100	9.90	45.28	24.0	218.40
2	粘性	10.0	45.0	4.200	4.90	10.34	45.0	189.00
3	砂礫	17.0	0.0	5.400	4.90	13.30	34.0	183.60
4	粘性	22.0	77.5	5.000	4.90	12.32	77.5	387.50
計				23.700		81.24		978.50

・地震時(液無)

層 No	土質	平均 N値	粘着力 (kN/m^2)	層厚 Li(m)	γ_i (kN/m^3)	W_s (kN)	f_i (kN/m^2)	$L_i \cdot f_i$ (kN/m)
1	砂質	12.0	0.0	9.100	9.90	45.28	24.0	218.40
2	粘性	10.0	45.0	4.200	4.90	10.34	45.0	189.00
3	砂礫	17.0	0.0	5.400	4.90	13.30	34.0	183.60
4	粘性	22.0	77.5	5.000	4.90	12.32	77.5	387.50
計				23.700		81.24		978.50

地盤から決まる極限支持力

常　時

$R_u = U \cdot \Sigma(L_i \cdot f_i)$

$= 2.513 \cdot 978.5 = 2{,}459$ (kN)

地震時(液無)

$R_u = U \cdot \Sigma(L_i \cdot f_i)$

$= 2.513 \cdot 978.5 = 2{,}459$ (kN)

W ：杭の有効重量(kN)

$W = \Sigma(W" \cdot L + W_o \cdot L_o)$ (kN)

W"：水中部単位長重量 (kN/m)

L ：水中部杭長 (m)

W_o ：水位上部単位長重量(kN/m)

L_o ：水位上部杭長 (m)

断面 No	W" (kN/m)	L (m)		W_o (kN/m)	L_o (m)		W_i (kN)	
		常時	地震時		常時	地震時	常時	地震時
1	3.672	29.100	29.100	6.080	1.900	1.900	118.398	118.398
計							118.398	118.398

許容支持力

常　時　$Ra = \frac{1.0}{3.0} \cdot (2459 - 81.2) + 81.2 - 118.4 = 756$ (kN)

地震時(液無)　$Ra = \frac{1.0}{2.0} \cdot (2459 - 81.2) + 81.2 - 118.4 = 1152$ (kN)

(c)　軸方向許容引抜き抵抗力の計算

$Pa = \frac{1}{n} \cdot Pu + W$

$P_u = U \cdot \Sigma(L_i \cdot f_i)$ (常　時), (地震時(液無))

$P_u = U \cdot \Sigma(L_i \cdot f_i \cdot DE_i)$ (地震時(液有))

P_a：杭頭における杭の軸方向許容引抜き抵抗力 (kN)

n ：安全率 6.0 (常　時)

3.0 (地震時)

P_u：地盤から決まる杭の極限引抜き抵抗力 (kN)

$P_u = 2.513 \cdot 978.5 = 2{,}459$ (kN) (常　時)

$P_u = 2.513 \cdot 978.5 = 2{,}459$ (kN) (地震時(液無))

W ：杭の有効重量 118.4 (kN) (常　時)

118.4 (kN) (地震時)

許容引抜力

常　時　$Pa = \frac{1}{6.0} \cdot 2459 + 118.4 = 528$ (kN)

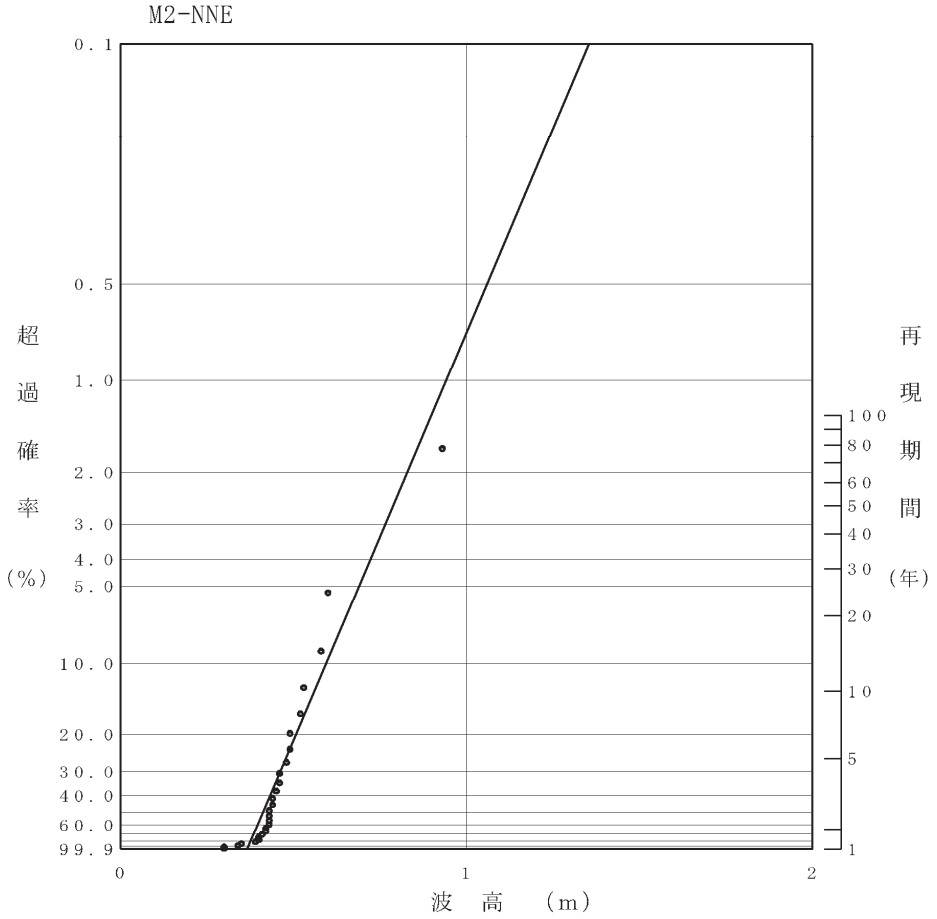
地震時(液無)　$Pa = \frac{1}{3.0} \cdot 2459 + 118.4 = 938$ (kN)

(d)　計算結果一覧

(kN/本)

許容支持	常　時	756
	地震時(液無)	1,152
許容引抜力	常　時	528
	地震時(液無)	938

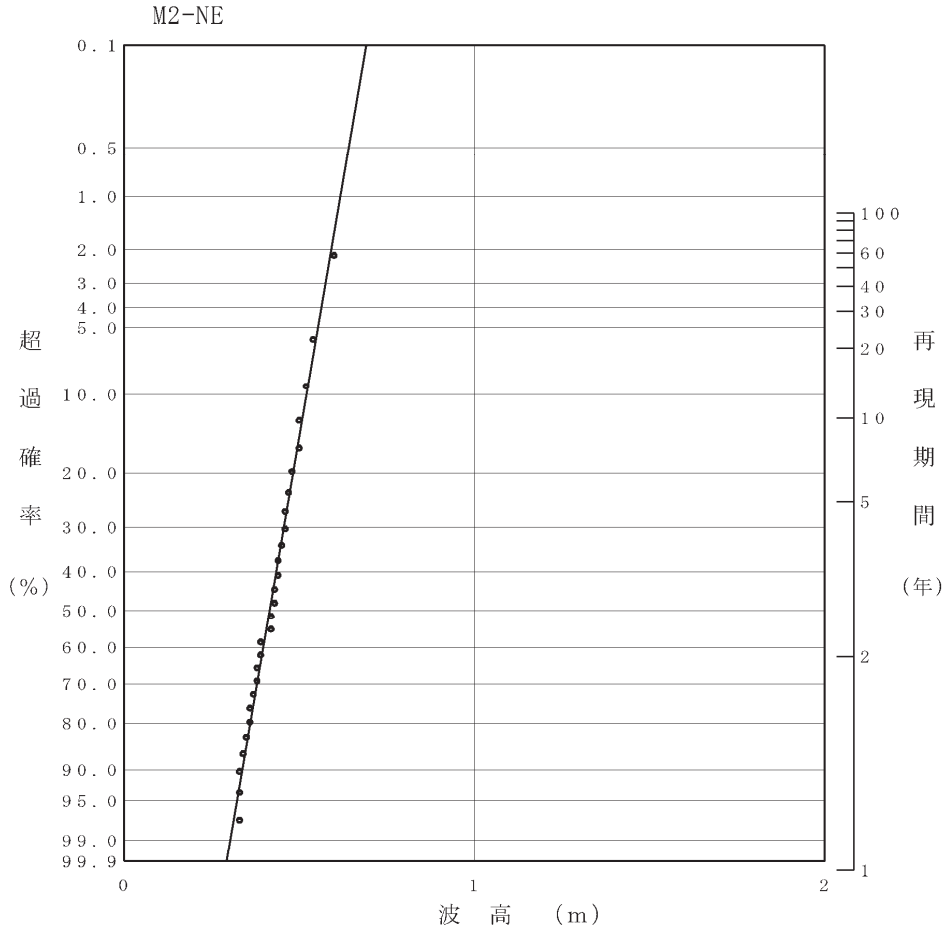
付属資料１　確率波高算出結果



データ数　　２７（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝０．７５）
相関係数　　０．９５５

確率年	期待値
５	０．４８
１０	０．５６
２０	０．６５
３０	０．７１
４０	０．７５
５０	０．７９
６０	０．８２

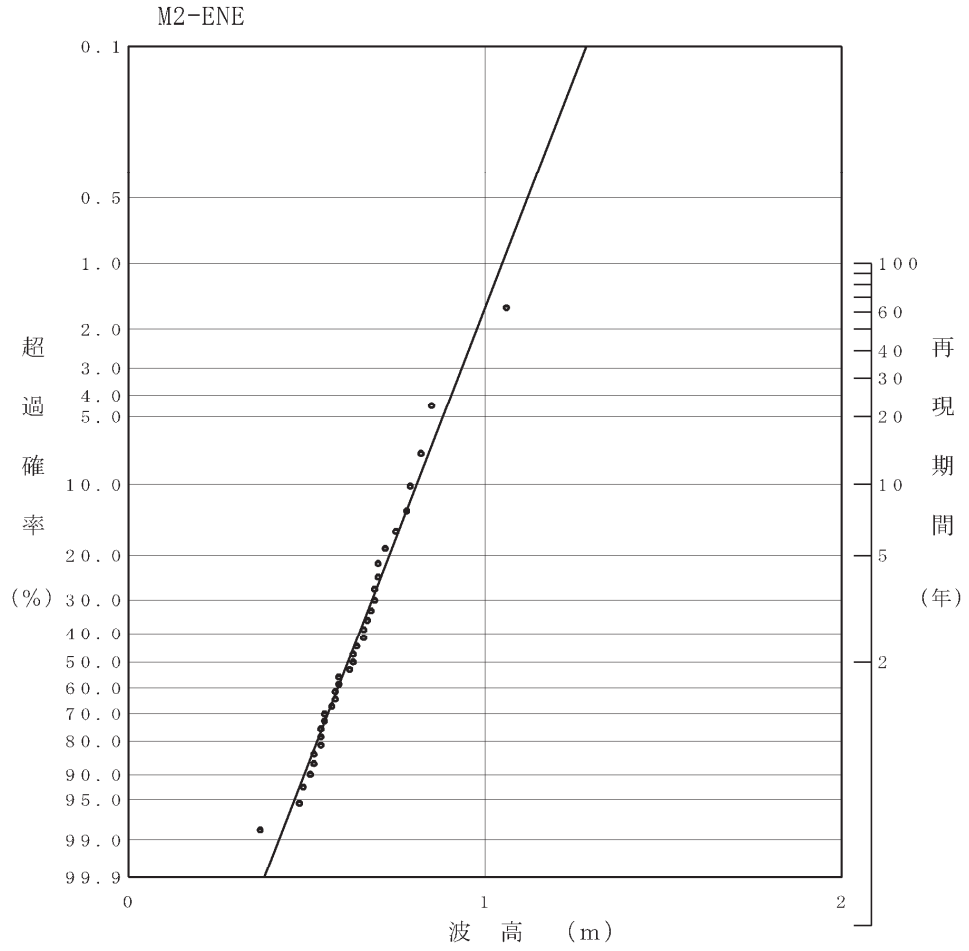
図1　M2地点(NNE)確率波高



データ数　　２８（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９９４

確率年	期待値
５	０．４７
１０	０．５１
２０	０．５４
３０	０．５６
４０	０．５７
５０	０．５８
６０	０．５９

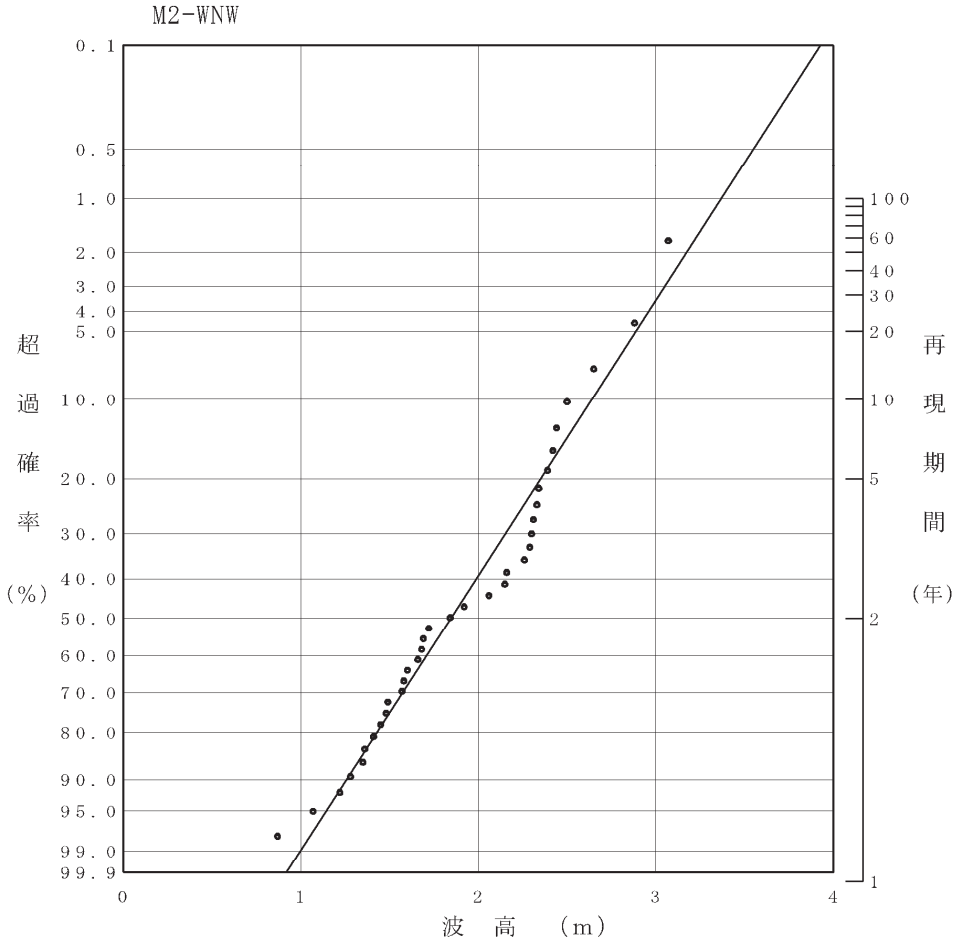
図2　M2地点(NE)確率波高



データ数	３５（３５年）
最適関数	ＧＵＭＢＥＬ分布
相関係数	０．９８８

確率年	期待値
５	０．７３
１０	０．８１
２０	０．８８
３０	０．９２
４０	０．９５
５０	０．９８
６０	１．００

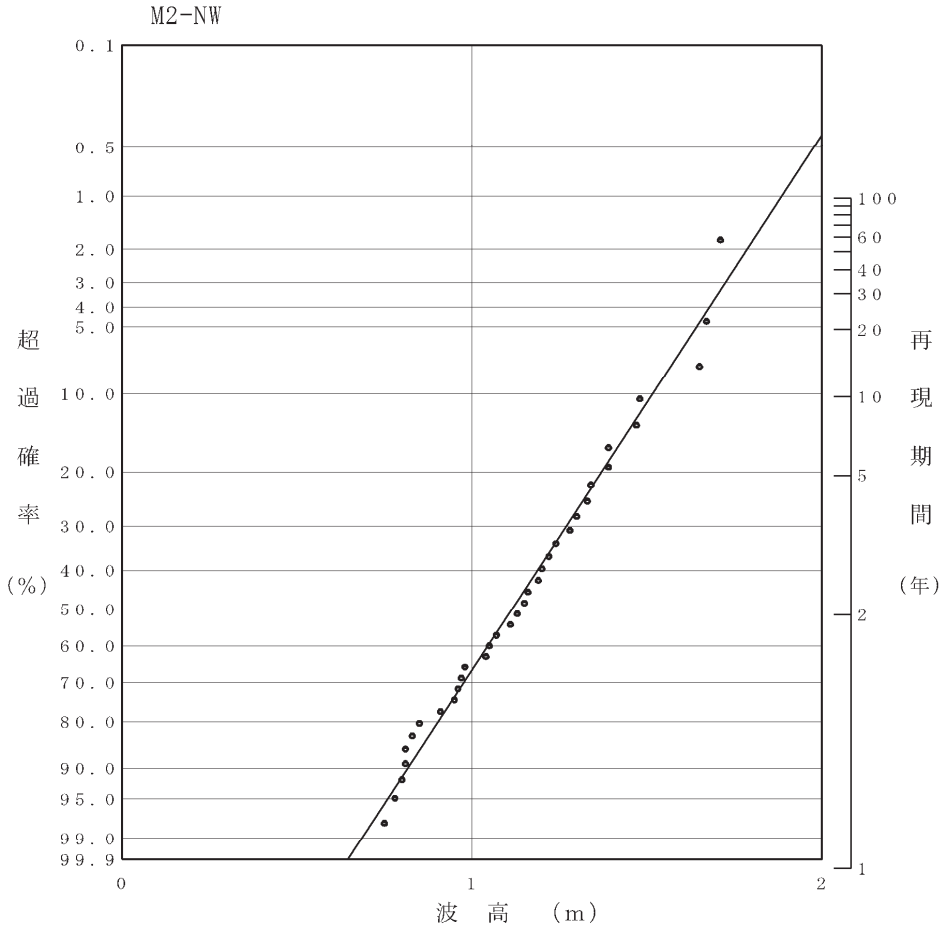
図3　M2地点(ENE)確率波高



データ数　　３５（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９８４

確率年	期待値
５	２．３５
１０	２．６４
２０	２．８９
３０	３．０２
４０	３．１１
５０	３．１７
６０	３．２３

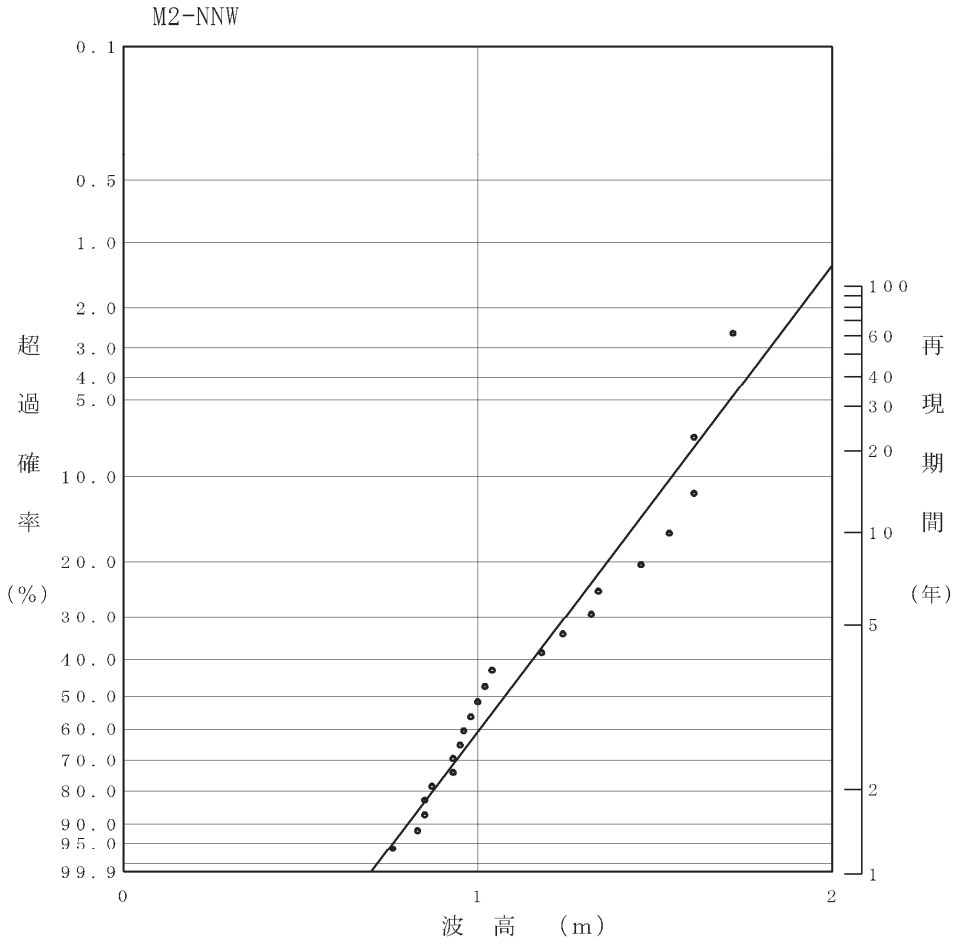
図4　M2地点(WNW)確率波高



データ数　　３４（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９９３

確率年	期待値
５	１．３６
１０	１．５１
２０	１．６４
３０	１．７０
４０	１．７５
５０	１．７８
６０	１．８１

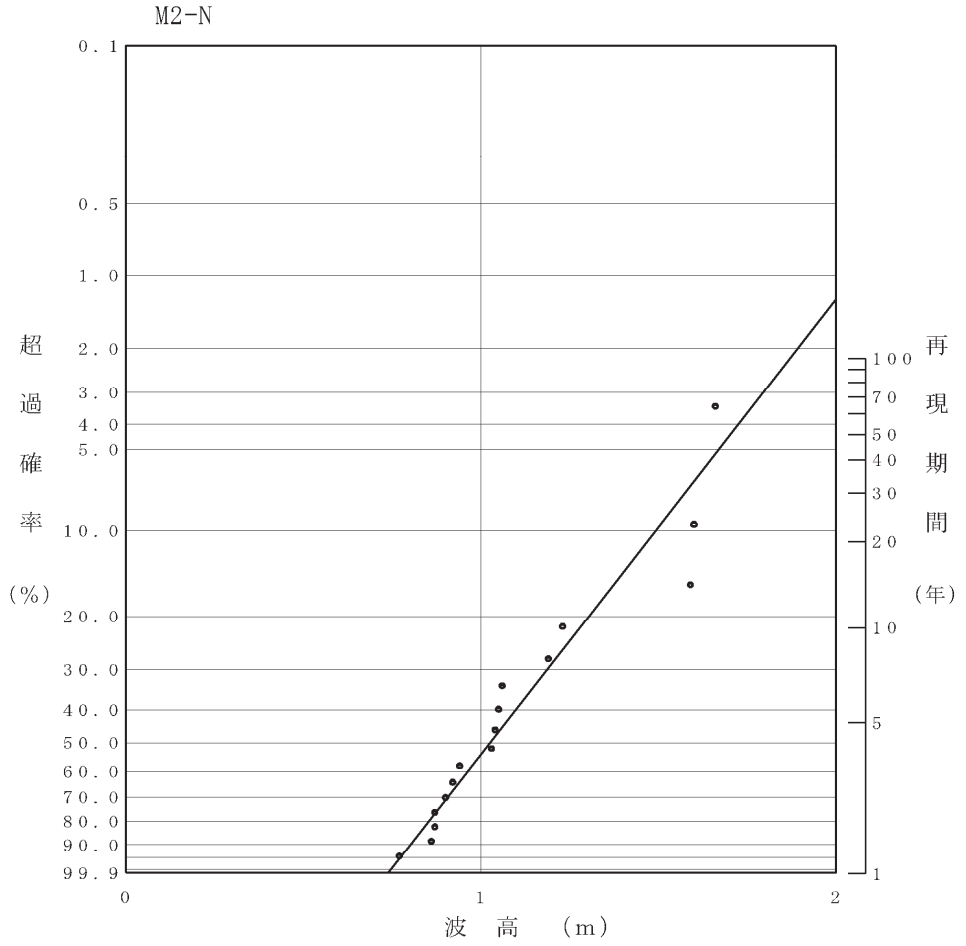
図5　M2地点(NW)確率波高



データ数　　２２（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝１．５０）
相関係数　　０．９７７

確率年	期待値
５	１．２３
１０	１．４３
２０	１．６０
３０	１．７０
４０	１．７６
５０	１．８１
６０	１．８５

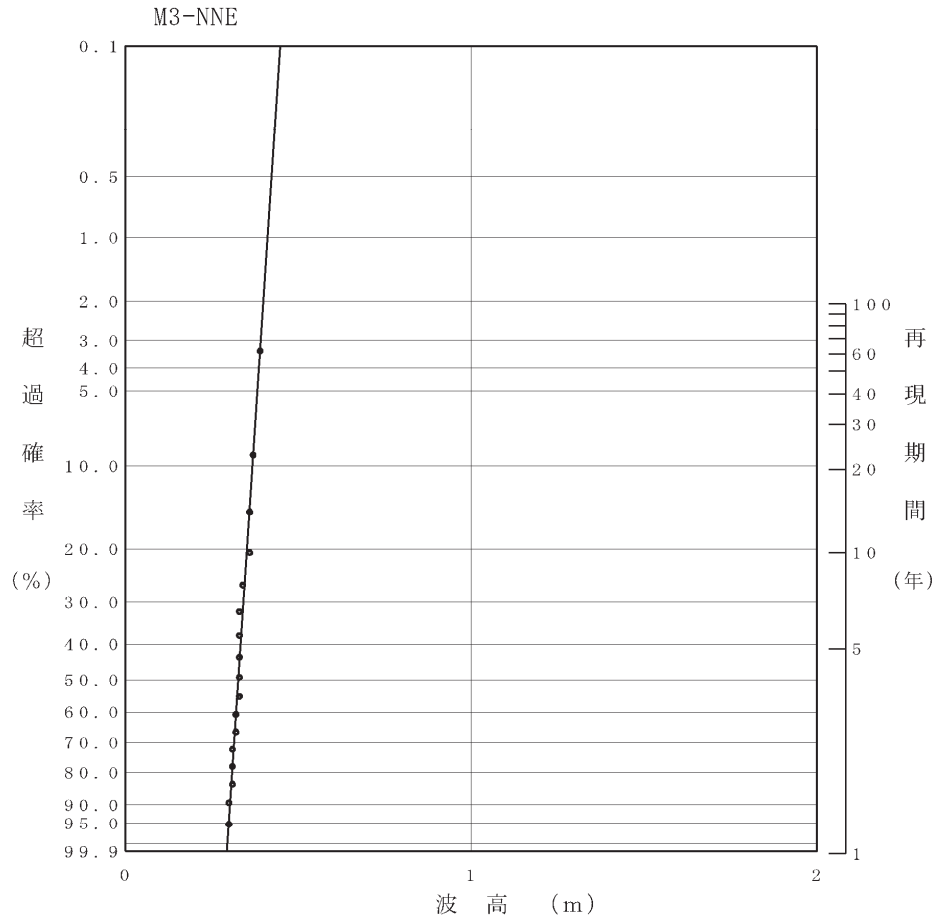
図6　M2地点(NNW)確率波高



データ数　　１６（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝１．２５）
相関係数　　０．９６４

確率年	期待値
５	１．０７
１０	１．２８
２０	１．４７
３０	１．５７
４０	１．６５
５０	１．７０
６０	１．７５

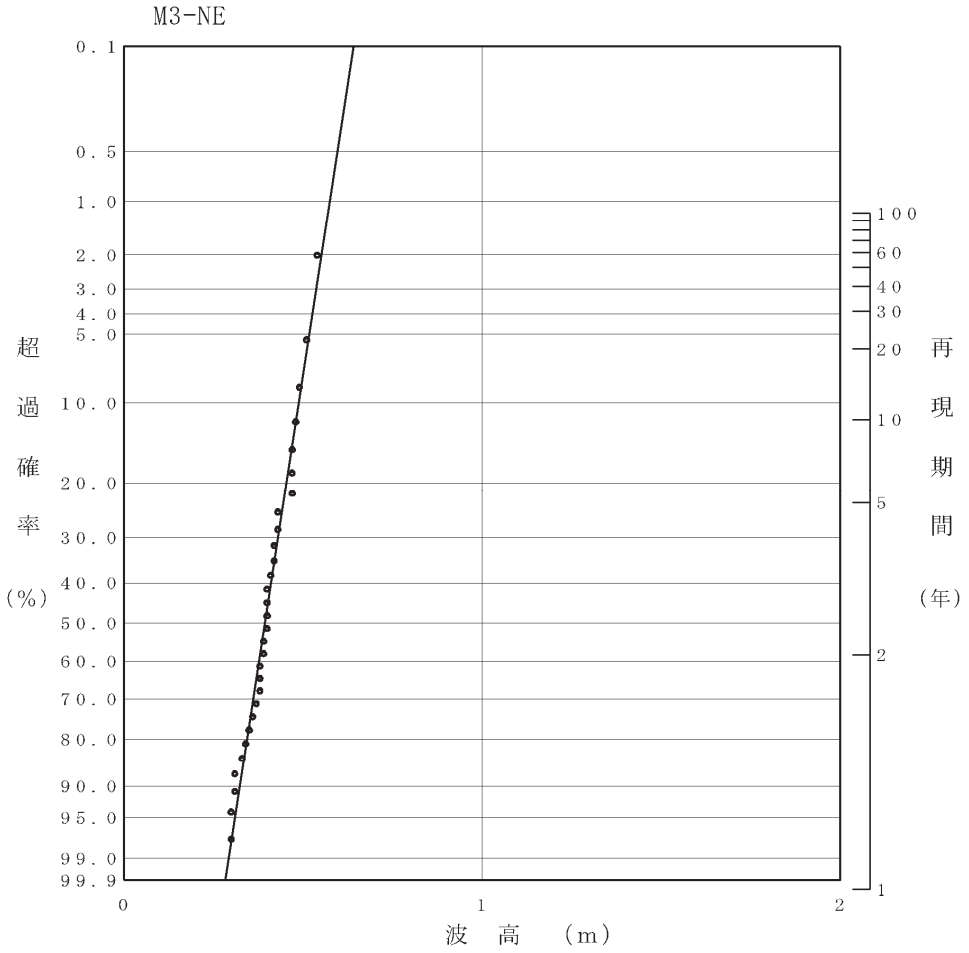
図7　M2地点(N)確率波高



データ数　　１７（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝１．５０）
相関係数　　０．９８４

確率年	期待値
５	０．３３
１０	０．３５
２０	０．３７
３０	０．３８
４０	０．３８
５０	０．３９
６０	０．３９

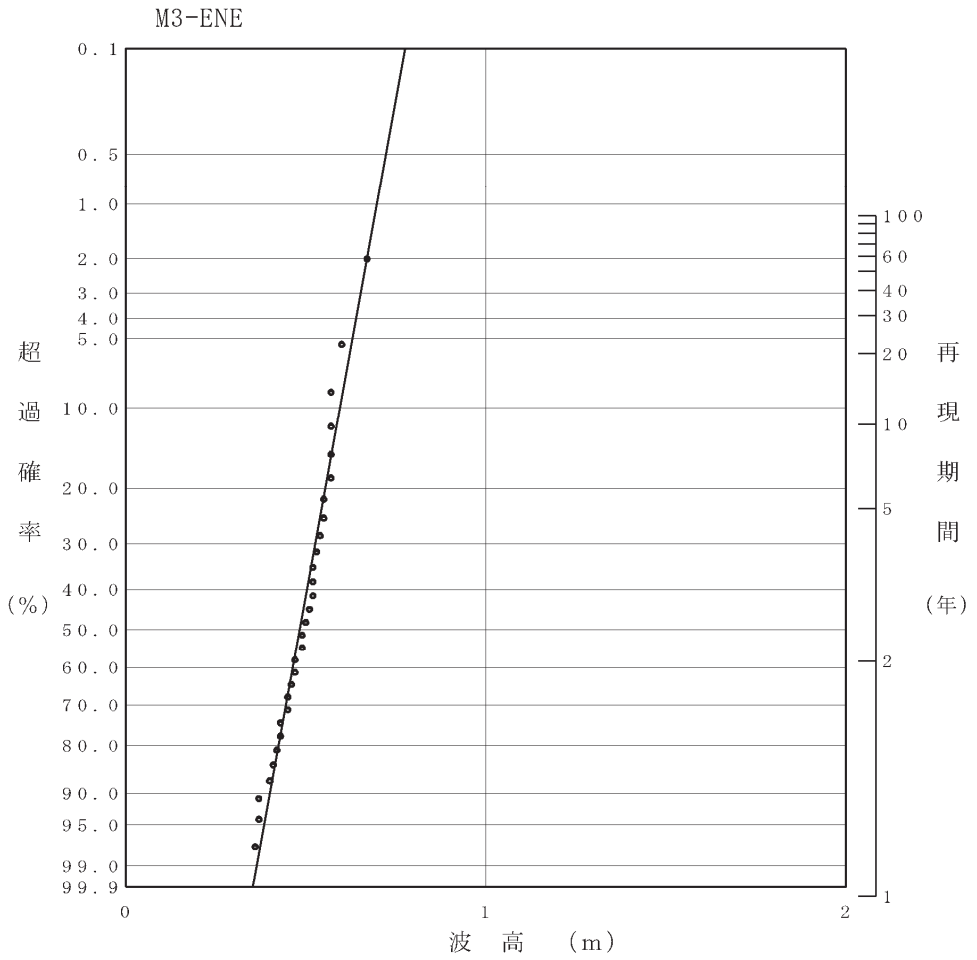
図8　M3地点(NNE)確率波高



データ数　　３０（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９８９

確率年	期待値
５	０．４５
１０	０．４８
２０	０．５１
３０	０．５３
４０	０．５４
５０	０．５５
６０	０．５５

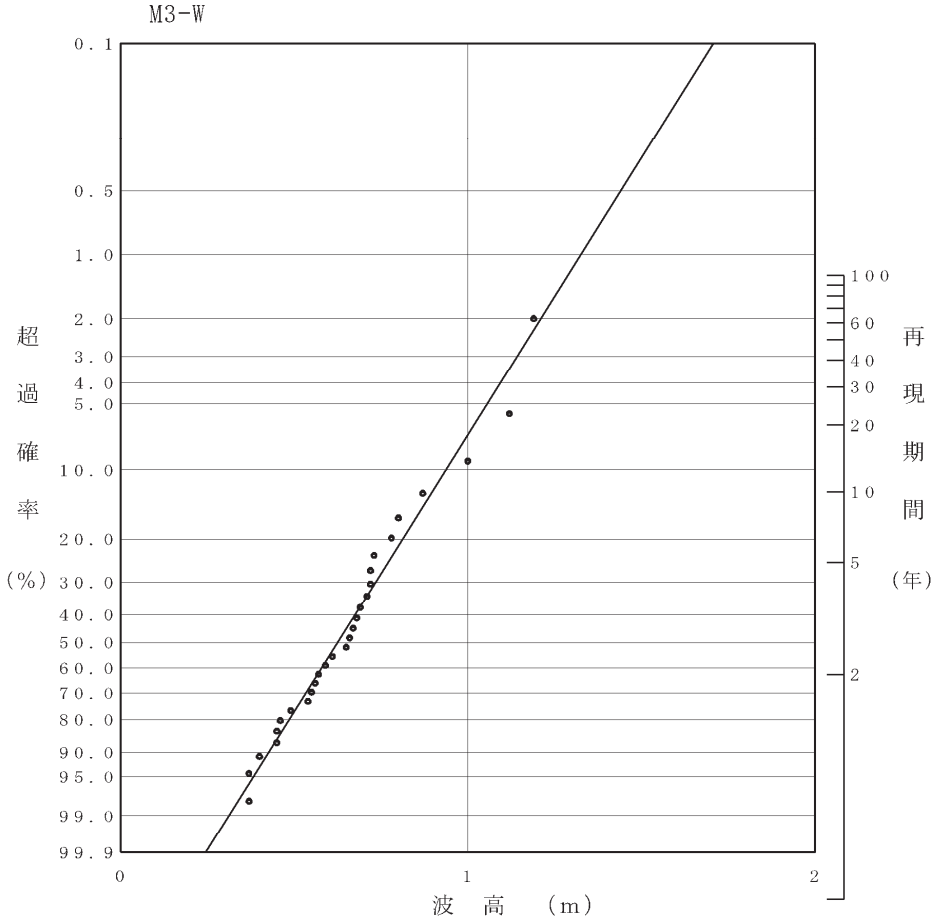
図9　M3地点(NE)確率波高



データ数　　３０（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９８３

確率年	期待値
５	０．５４
１０	０．５９
２０	０．６２
３０	０．６４
４０	０．６５
５０	０．６６
６０	０．６７

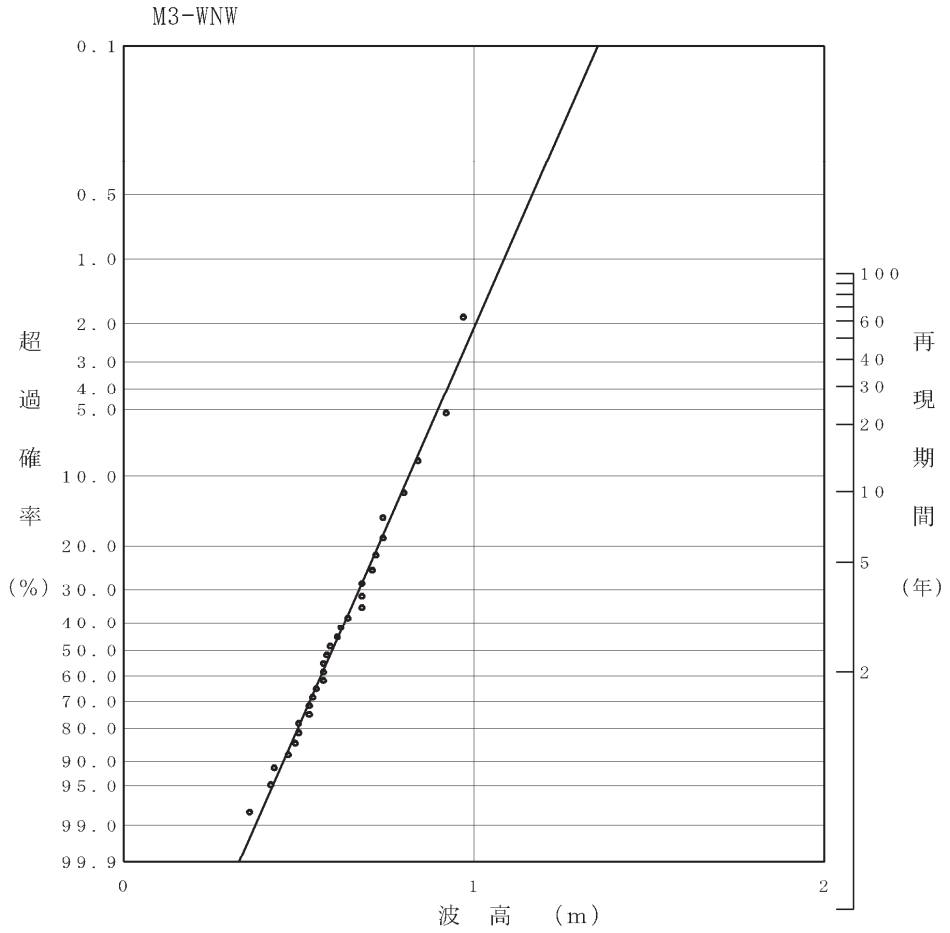
図10　M3地点(ENE)確率波高



データ数	２８（３５年）
最適関数	ＧＵＭＢＥＬ分布
相関係数	０．９８９

確率年	期待値
５	０．７７
１０	０．９０
２０	１．０２
３０	１．０９
４０	１．１３
５０	１．１７
６０	１．２０

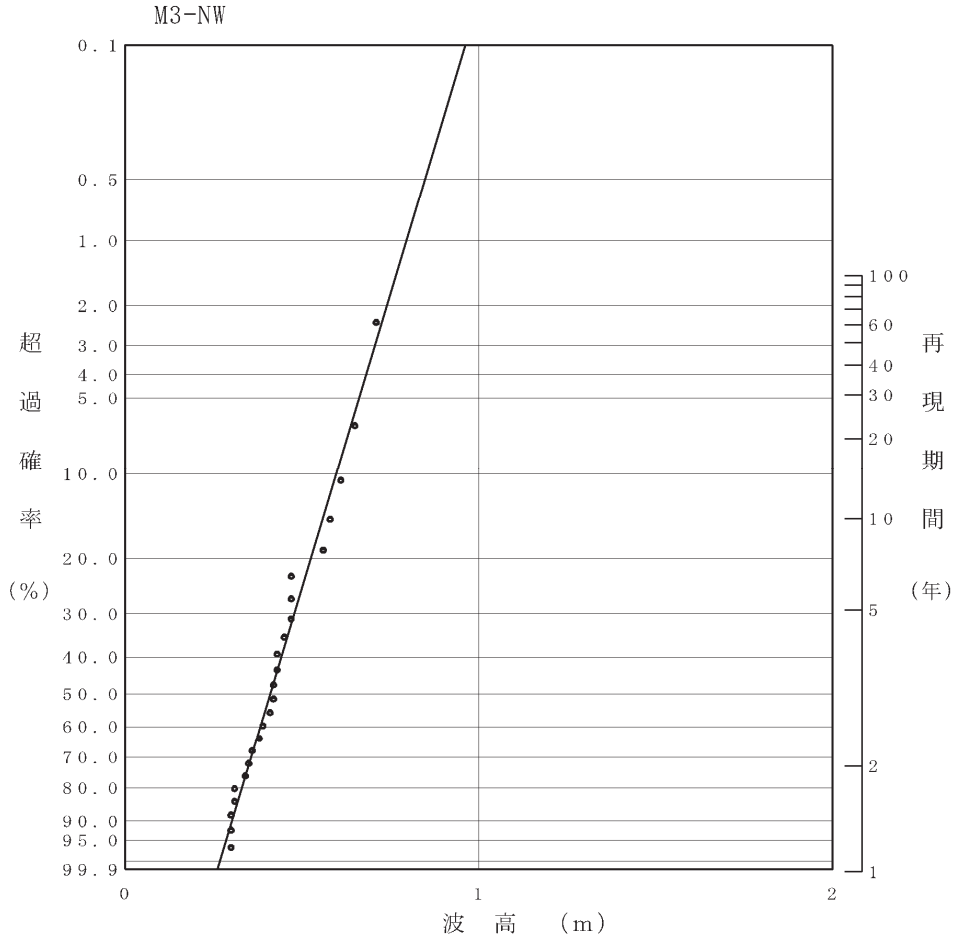
図11　M3地点(W)確率波高



データ数	３０（３５年）
最適関数	ＧＵＭＢＥＬ分布
相関係数	０．９９４

確率年	期待値
５	０．７１
１０	０．７９
２０	０．８８
３０	０．９３
４０	０．９６
５０	０．９９
６０	１．０１

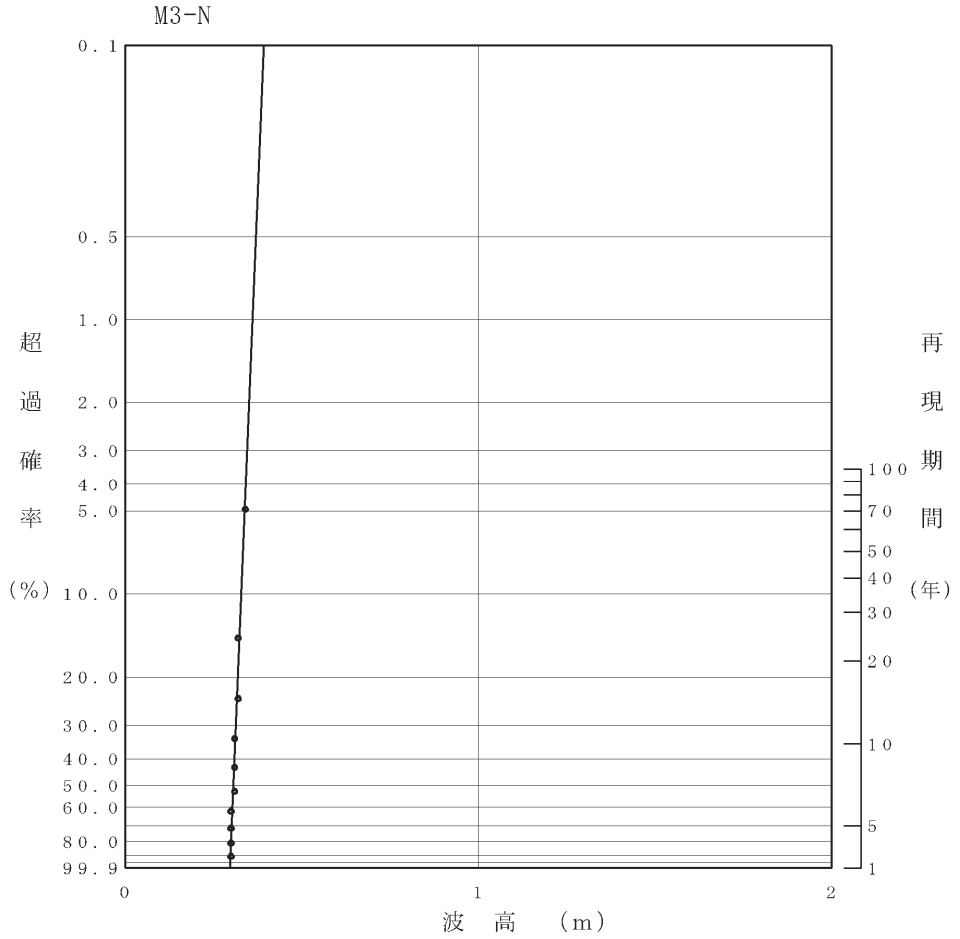
図12　M2地点(WNW)確率波高



データ数　　２４（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝１．５０）
相関係数　　０．９９０

確率年	期待値
５	０．４８
１０	０．５６
２０	０．６３
３０	０．６６
４０	０．６９
５０	０．７１
６０	０．７２

図13　M3地点(NW)確率波高

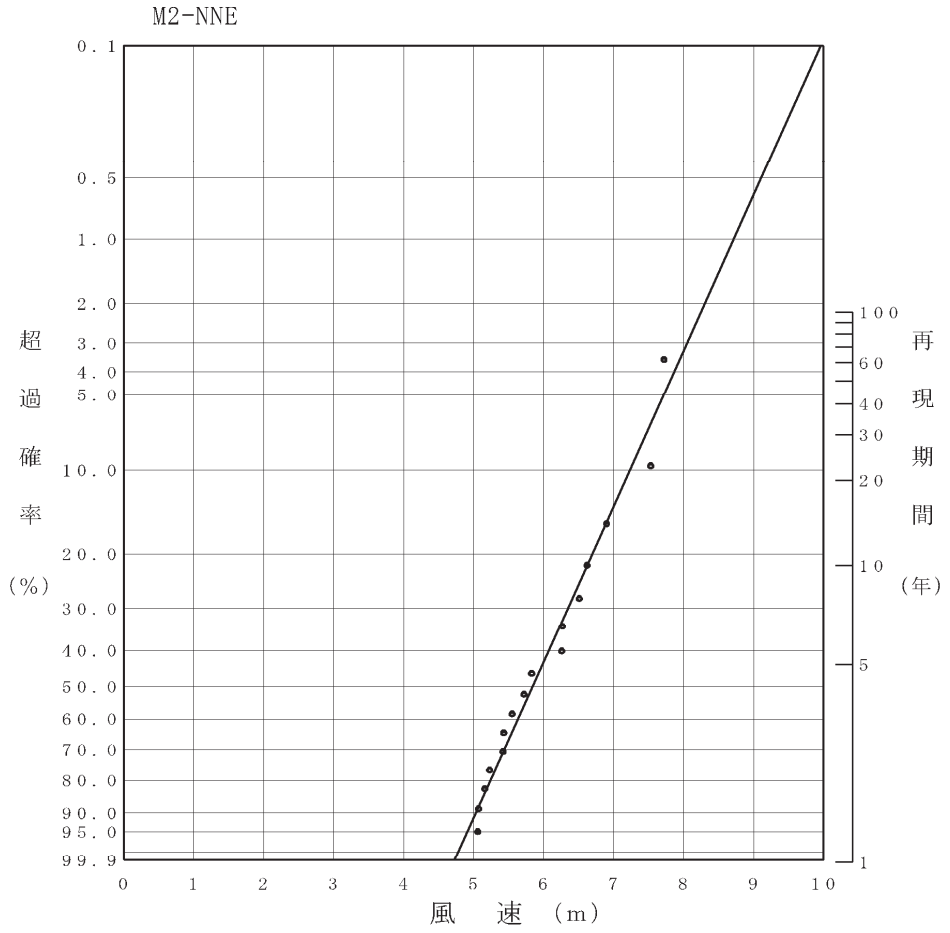


データ数　　１０（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝１．００）
相関係数　　０．９７７

確率年	期待値
５	０．３０
１０	０．３１
２０	０．３２
３０	０．３３
４０	０．３３
５０	０．３３
６０	０．３４

図14　M3地点(N)確率波高

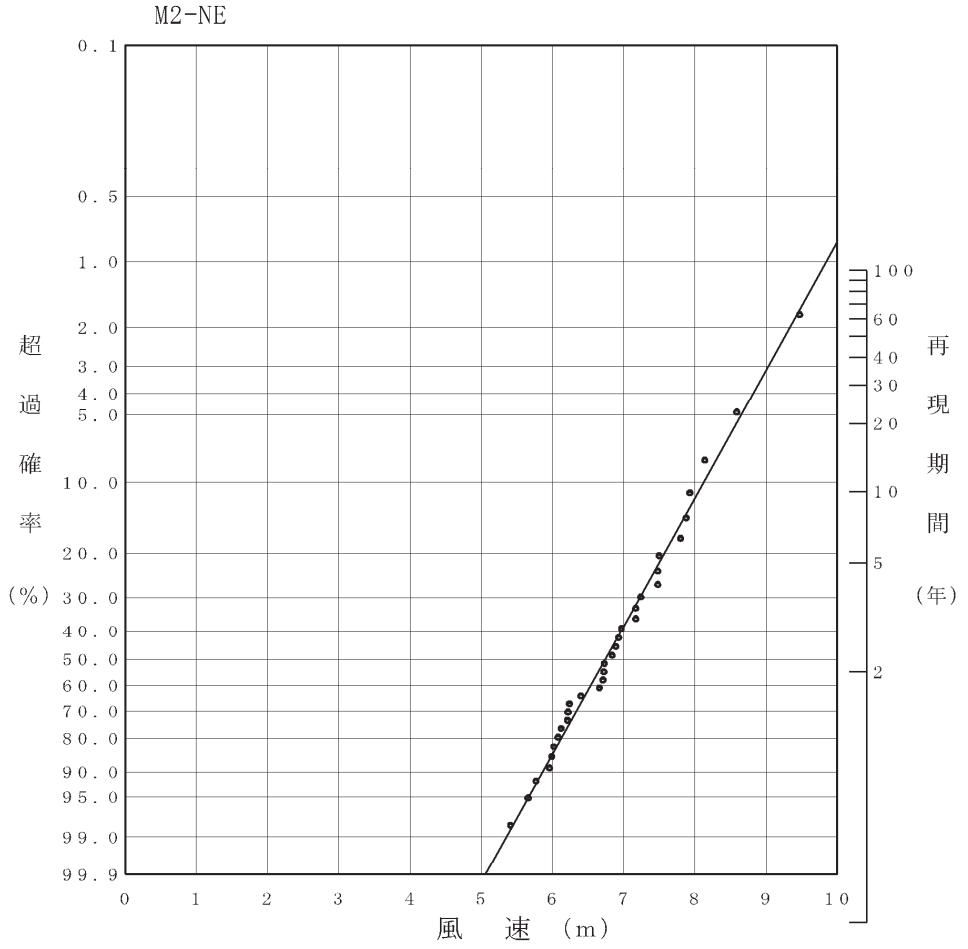
付属資料 2　確率風速算出結果



データ数　　１６（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝１．５０）
相関係数　　０．９８９

確率年	期待値
５	５．９８
１０	６．６２
２０	７．１７
３０	７．４６
４０	７．６６
５０	７．８０
６０	７．９２

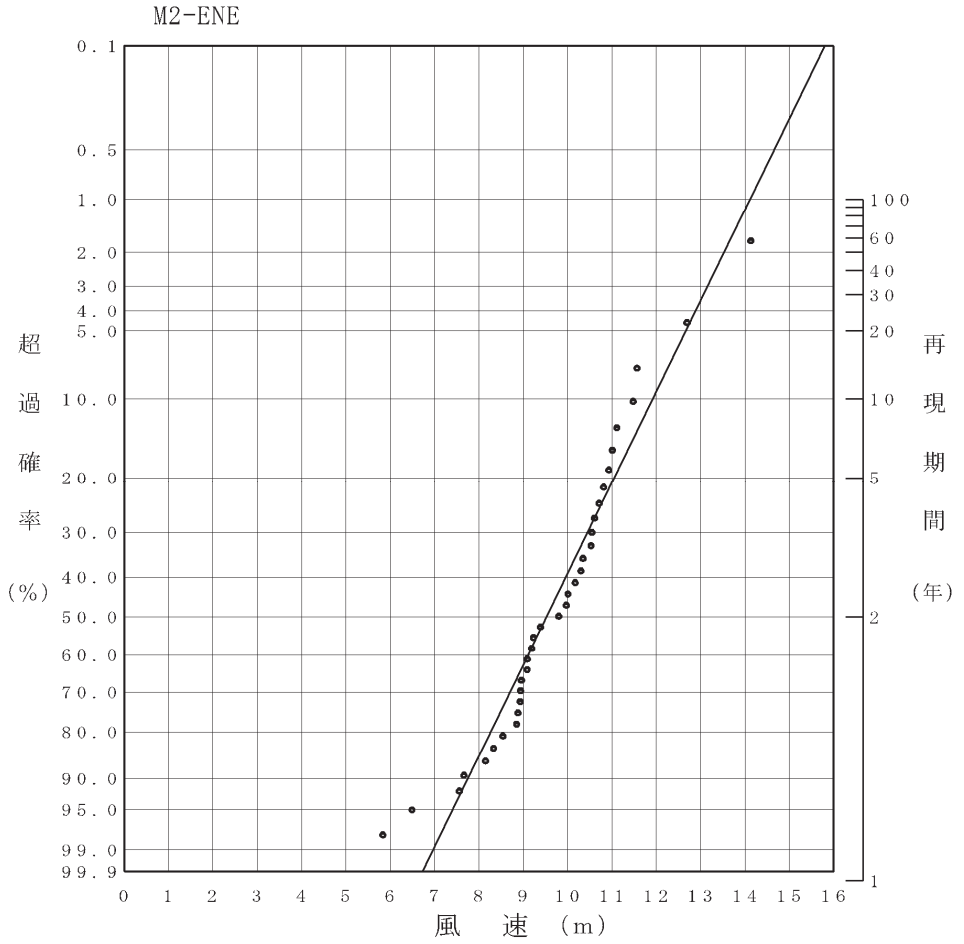
図1　M2地点(NNE)確率風速



データ数　　３２（３５年）
最適関数　　ＧＵＭＢＥＬ分布
相関係数　　０．９９６

確率年	期待値
５	７．５０
１０	８．０５
２０	８．５８
３０	８．８９
４０	９．１０
５０	９．２７
６０	９．４０

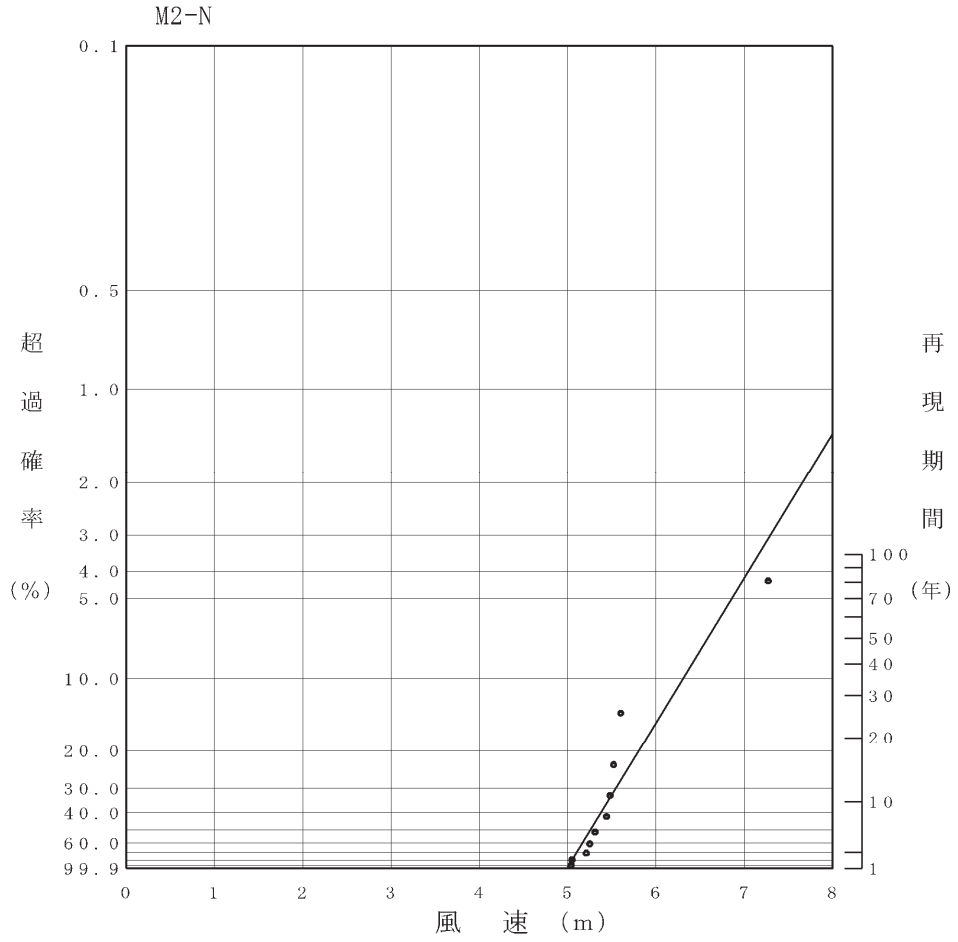
図2　M2地点(NE)確率風速



データ数　　３５（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９７１

確率年	期待値
５	１１．０５
１０	１１．９２
２０	１２．６６
３０	１３．０６
４０	１３．３３
５０	１３．５３
６０	１３．６８

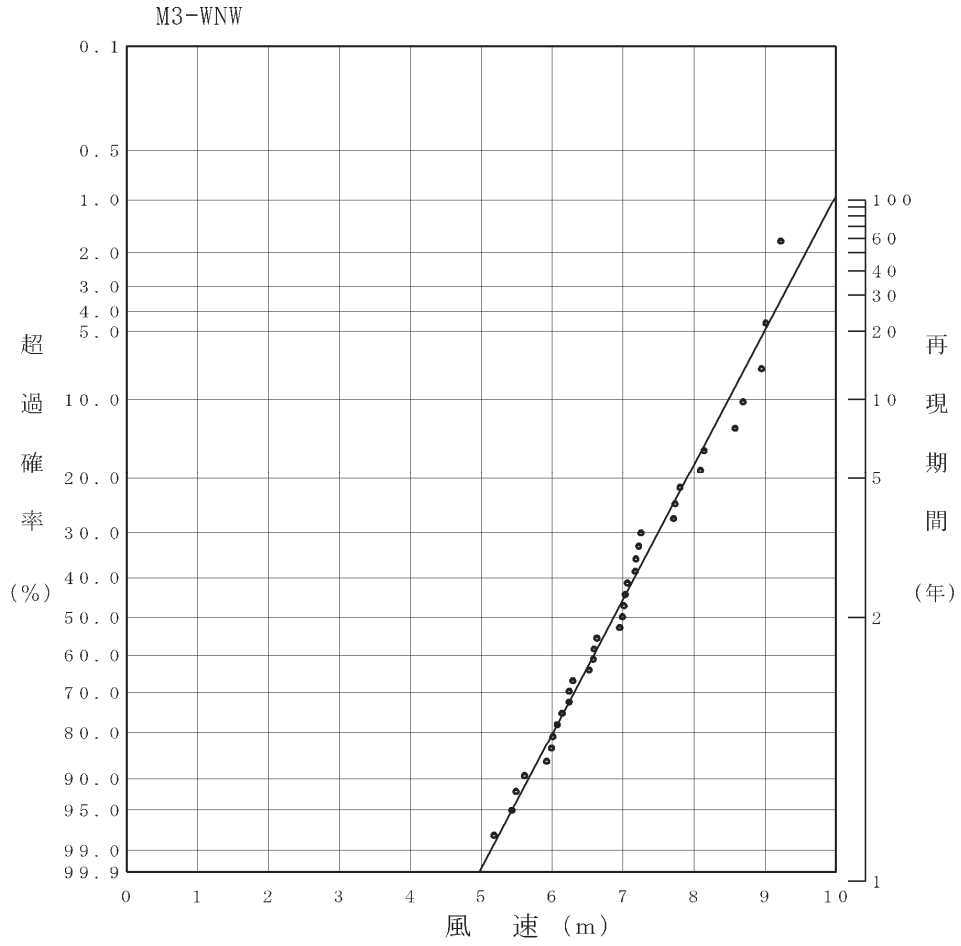
図3　M2地点(ENE)確率風速



データ数　　１０（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝０．７５）
相関係数　　０．９４９

確率年	期待値
５	５．１０
１０	５．４５
２０	５．９０
３０	６．１９
４０	６．４１
５０	６．５８
６０	６．７３

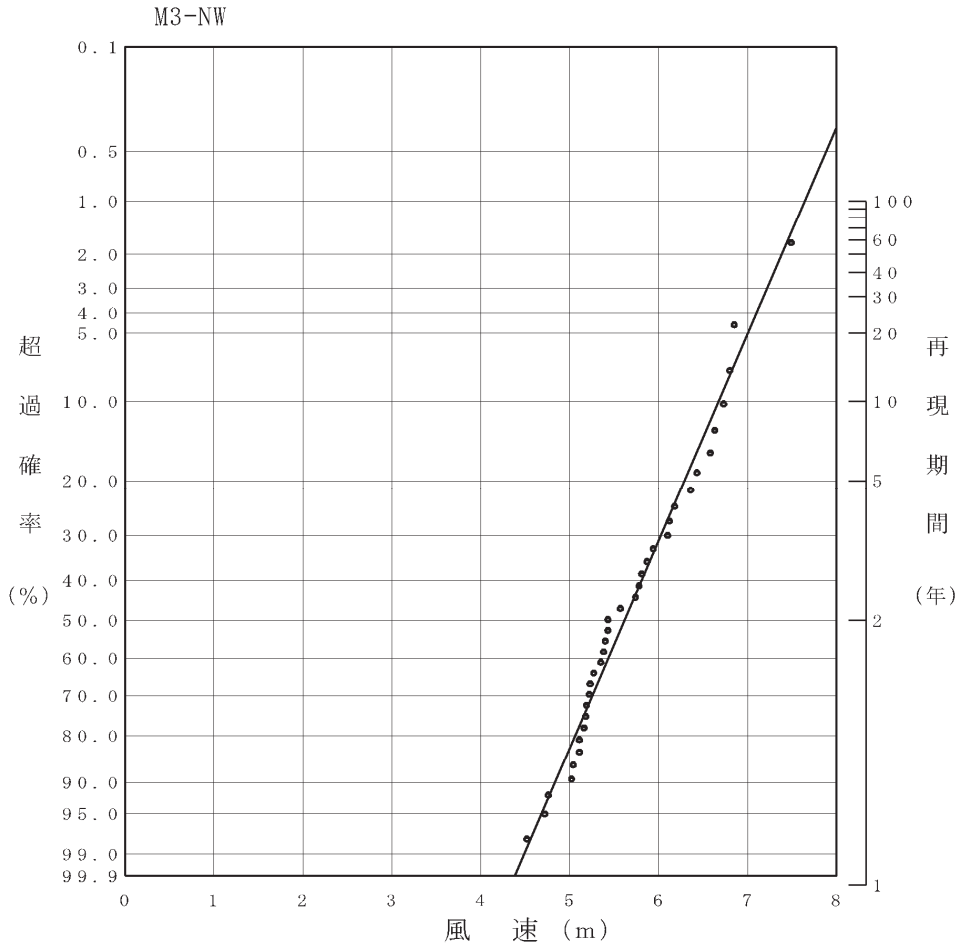
図4　M2地点(N)確率風速



データ数　　３５（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９９２

確率年	期待値
５	７．９０
１０	８．４８
２０	８．９９
３０	９．２６
４０	９．４４
５０	９．５７
６０	９．６８

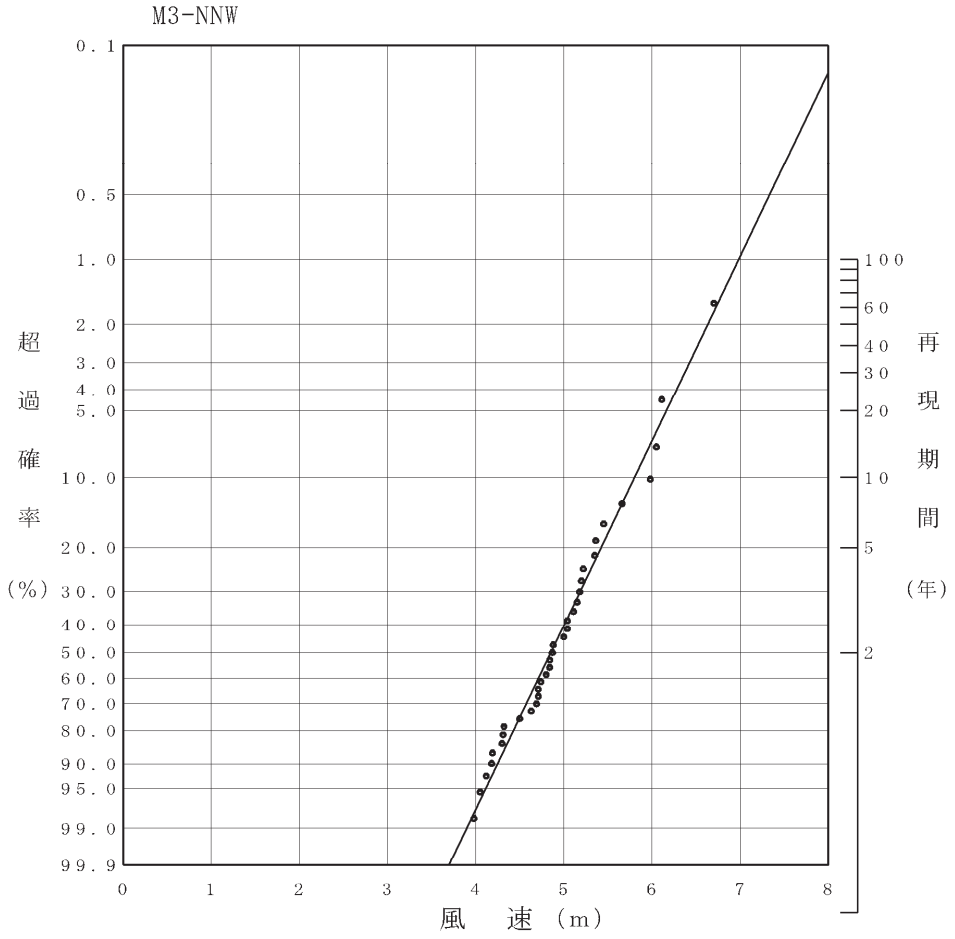
図5　M3地点(WNW)確率風速



データ数　　３５（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝２．００）
相関係数　　０．９９１

確率年	期待値
５	６．２９
１０	６．６７
２０	７．００
３０	７．１８
４０	７．２９
５０	７．３８
６０	７．４５

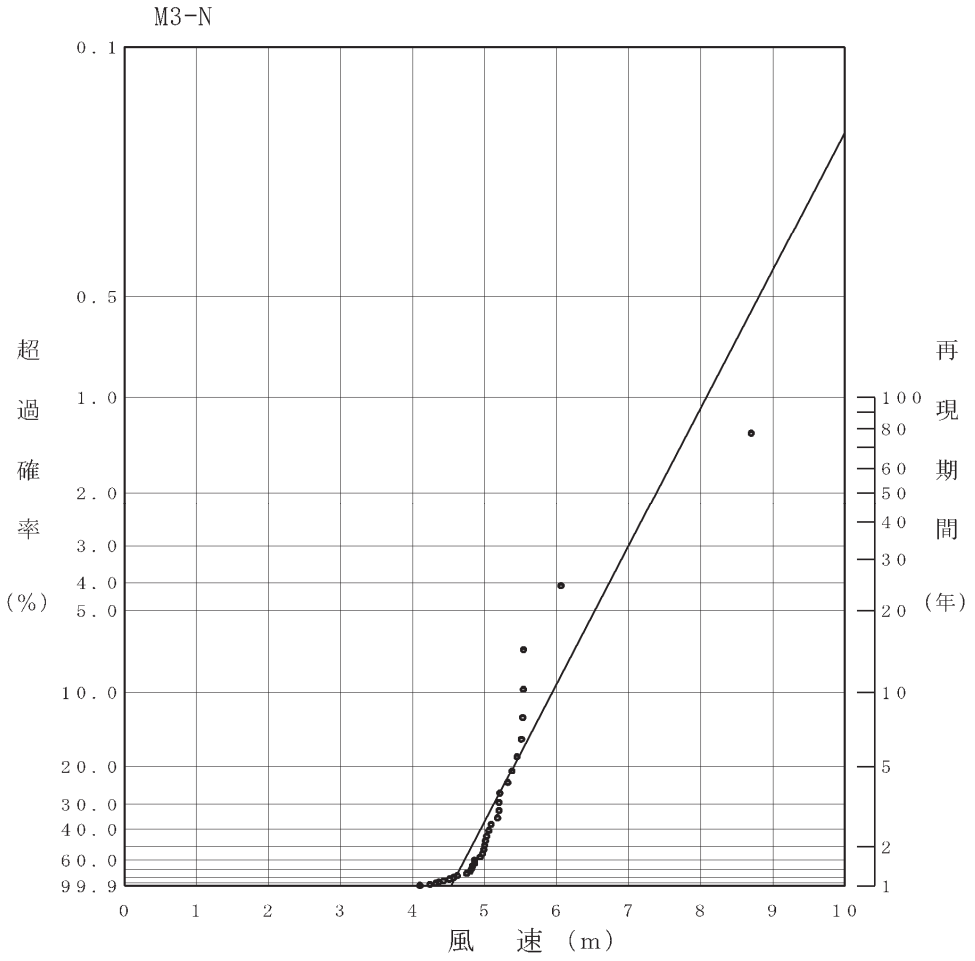
図6　M3地点(NW)確率風速



データ数　　３５（３５年）
最適関数　　ＧＵＭＢＥＬ分布
相関係数　　０．９９３

確率年	期待値
５	５．４２
１０	５．８０
２０	６．１６
３０	６．３７
４０	６．５２
５０	６．６３
６０	６．７２

図7　M3地点(NNW)確率風速



データ数　　３５（３５年）
最適関数　　ＷＥＩＢＵＬＬ分布
　　（ｋ＝０．７５）
相関係数　　０．９２８

確率年	期待値
５	５．４０
１０	５．９４
２０	６．５３
３０	６．９０
４０	７．１７
５０	７．３８
６０	７．５６

図8　M3地点(N)確率風速

付属資料 3　エネルギー平衡方程式

エネルギー平衡方程式基礎方程式

波の不規則性を考慮したエネルギー平衡方程式に基づく計算法は、沖側での波浪諸元(スペクトル形を含む)を与え、これが水深変化に伴って変形する過程を次式のエネルギー平衡方程式を数値的に解くことによって求め、対象地点での換算沖波波高等を算定するものである。

$$\frac{\partial}{\partial x}\left(C_g \cos\theta \cdot D\right)+\frac{\partial}{\partial y}(C_g \sin\theta \cdot D)+\frac{\partial}{\partial \theta}\left(\frac{Cg}{C}\left(\frac{\partial C}{\partial x}\sin\theta-\frac{\partial C}{\partial y}\cos\theta\right)D\right)=0 \qquad (3.1)$$

ここで、x,yは座標,は波向き,Dは方向スペクトル,Cgは群速度,C は波速である。

計算方法の詳細は以下の通りである。

方向スペクトルをDとし、外部エネルギーの授受を Q、エネルギー伝播速度ベクトルを$\vec{V}$とすると、エネルギー平衡方程式は次のように表される。

$$\frac{\partial D}{\partial t}+\nabla\cdot\left(D\vec{V}\right)+Q=0 \qquad (3.2)$$

ここに、

$$\left.\begin{aligned}
&\nabla=\left(\frac{\partial}{\partial x},\frac{\partial}{\partial y},\frac{\partial}{\partial f},\frac{\partial}{\partial \theta}\right)\\
&\vec{V}=\begin{Bmatrix}V_x\\V_y\\V_f\\V_\theta\end{Bmatrix}=\begin{Bmatrix}C_g\cos\theta\\C_g\sin\theta\\\dfrac{\partial f}{\partial t}\\\dfrac{C_g}{C}\left(\dfrac{\partial C}{\partial x}\sin\theta-\dfrac{\partial C}{\partial y}\cos\theta\right)\end{Bmatrix}\\
&C_g=\frac{C}{2}\left(1+\frac{2kd}{\sinh 2kd}\right)
\end{aligned}\right\} \qquad (3.3)$$

Cgは群速度、Cは速度、 kは波数、dは水深　である。

ここで、①波は時間的に変化しない、②成分波の周期は変化しない、③外部からはエネルギーを受けないと仮定すると式(3.1)は次のように書き直せる。

$$\frac{\partial(DV_x)}{\partial x}+\frac{\partial(DV_y)}{\partial y}+\frac{\partial(DV_\theta)}{\partial \theta}=0 \qquad (3.4)$$

式(3.4)を D について解けば、ある地点における波の状態がわかることになる。しかし、一般に、式(3.4)を解析的に解くことは困難なため、実際には各項について差分法を使用して式(3.4)は解かれる。

すなわち、対象領域を一定間隔の格子網で覆い各格子点で水深等の条件を与え地形を格子で近似して計算を行う。

計算は、まず、最も沖側格子行でその地点の方向スペクトルが提案方向スペクトル(通常は深海波のスペクトル)に等しいという条件を与える。沖側境界以降は、各行ごとにエネルギー平衡方程式(式(3.4))を差分法で解き方向スペクトルの分布を求める。この各行毎の計算を沖から岸側に向かって順次進め、対象領域内すべての格子点における方向スペクトルの分布が求められる。

この際の側方の境界条件は、海域側と陸域側を分けて次のような条件とする。

・海域側： 内外のスペクトルを同一とする
・陸域側： 波のエネルギーは陸部で吸収されるものとする

このようにして、ある地点の方向スペクトルが求まれば、それから屈折・浅水変形後の波浪諸元が求まることになる。また、島や構造物背後の遮蔽効果は、島、構造物よりエネルギーの流入が無いものとすると方向分散効果が考慮される。

不規則波のスペクトル形としては、周波数スペクトルとしてブレッドシュナイダー・光易型を、方向分布関数には光易型を用いる。

$$\left.\begin{aligned}
&S(f)=0.257H_{1/3}{}^2T_{1/3}(T_{1/3}f)^{-5}\exp[-0.103(T_{1/3}f)^{-4}]\\
&G(f,\theta)=G_0\cos^{2s}(\theta/2)\quad,\quad G_0=\left[\int_{\theta_{\min}}^{\theta_{\max}}\cos^{2s}(\theta/2)d\theta\right]^{-1}\\
&S=\begin{cases}S_{\max}(f/f_p)^{-2.5} & (f>f_p)\\ S_{\max}(f/f_p)^{5} & (f<f_p)\end{cases}\\
&f_p=1/(1.05T_{1/3})
\end{aligned}\right\} \qquad (3.5)$$

ここで、$S_{\max}$ は方向集中度を示すパラメータで、スペクトルのピーク周波数における S の値である。

a） 浅水変形

微小振幅波理論による浅水変形は、次式で計算する。

$$\left.\begin{aligned} K_s &= \frac{H}{H_0'} = \sqrt{\frac{1}{2n}\frac{C_0}{C}} \\ n &= \frac{1}{2}\left\{1 + \frac{4\pi h/L}{\sinh(4\pi h/L)}\right\} \\ C_0 &= \frac{g}{2\pi}T \\ C &= \frac{L}{T} = \sqrt{\frac{gL}{2\pi}\tanh\frac{2\pi h}{L}} \end{aligned}\right\} \qquad (3.6)$$

ここで、*Ks* は浅水係数，*H* は水深 *h* における波高，*Ho* は換算沖波波高，*Co* は深海での波速，*C* は水深 *h* における波速，*L* は水深 *h* における波長である。

上記の浅水変形に関する式は、浅海域を進行した波が砕波点に近づき、波形勾配が大きくなるとこの式が成り立たなくなるため、次に示す非線形長波理論による浅水変形を考慮する。

$$\left.\begin{aligned} K_s &= \frac{1}{\sqrt{\left\{1 + \frac{4\pi h/L}{\sinh(4\pi h/L)}\tanh\frac{2\pi h}{L}\right\}}} && \left(\frac{gHT^2}{h^2} \le 30\right) \\ Hh^{2/7} &= const. && \left(30 \le \frac{gHT^2}{h^2} < 50\right) \\ Hh^{5/2}&\left\{\sqrt{gHT^2/d^2 - 2/\sqrt{3}}\right\} = const. && \left(50 \le \frac{gHT^2}{h^2}\right) \end{aligned}\right\} \qquad (3.7)$$

付属資料 4　DILI 港付近の設計波計算結果

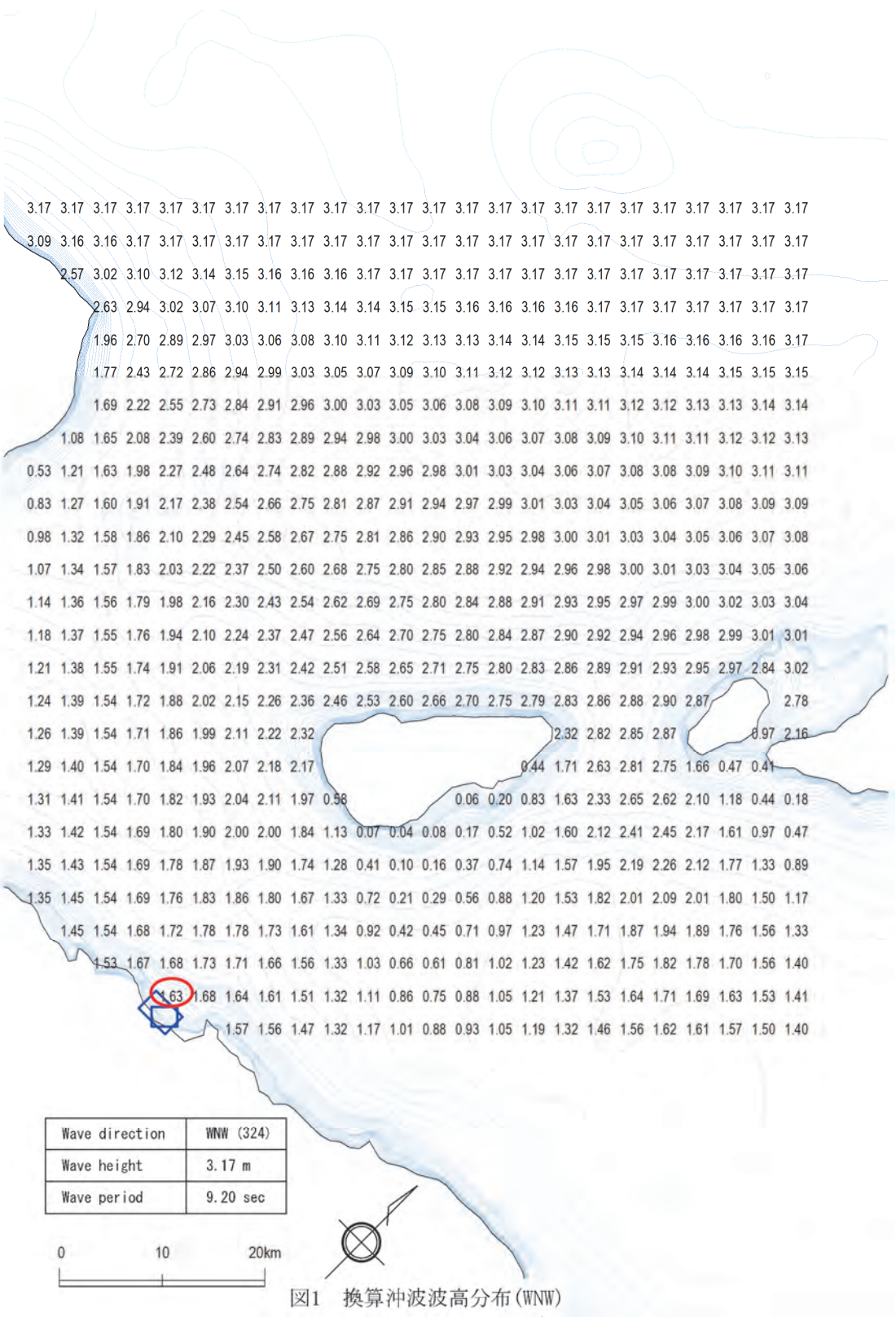


図1　換算沖波波高分布(WNW)

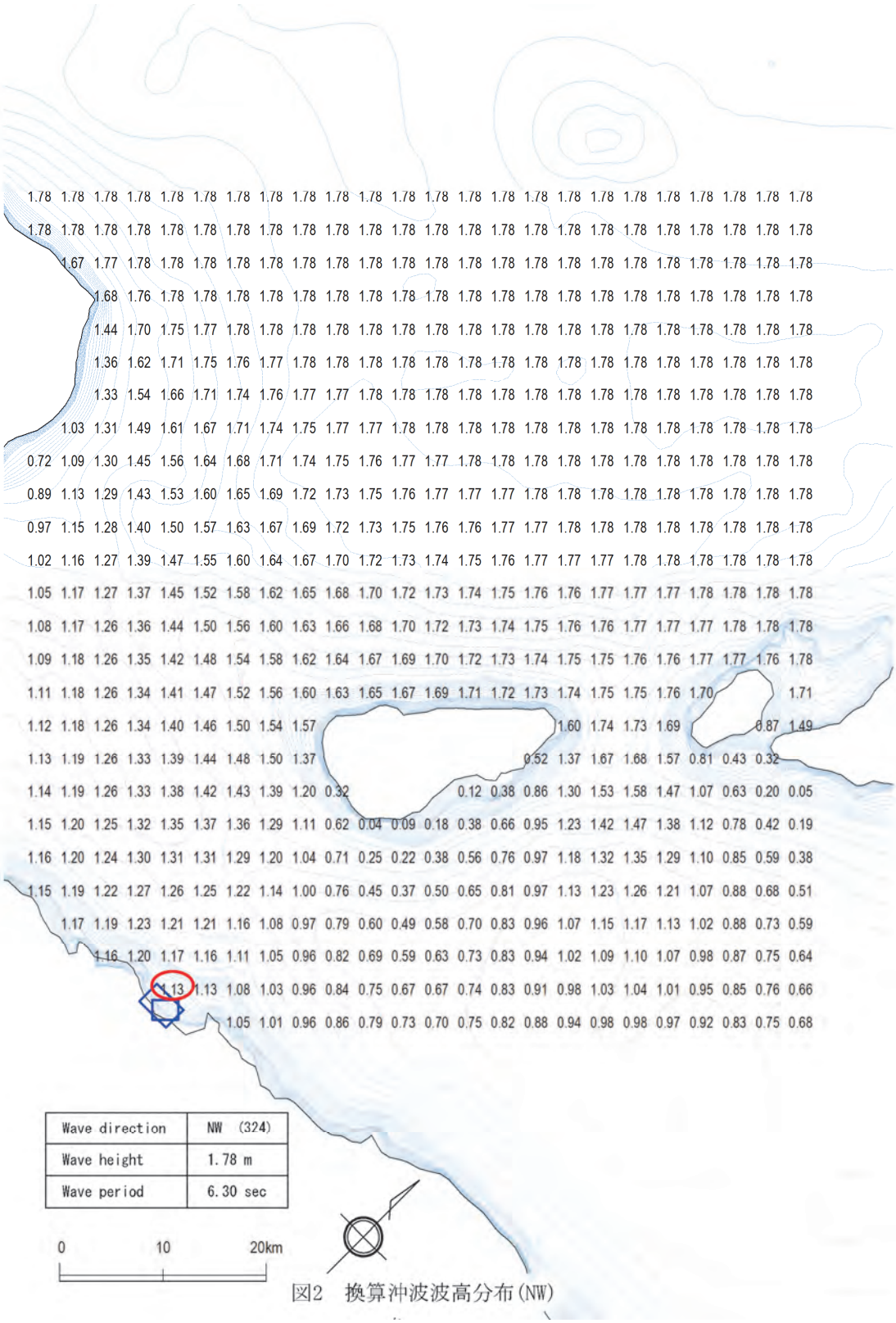


図2　換算沖波波高分布(NW)

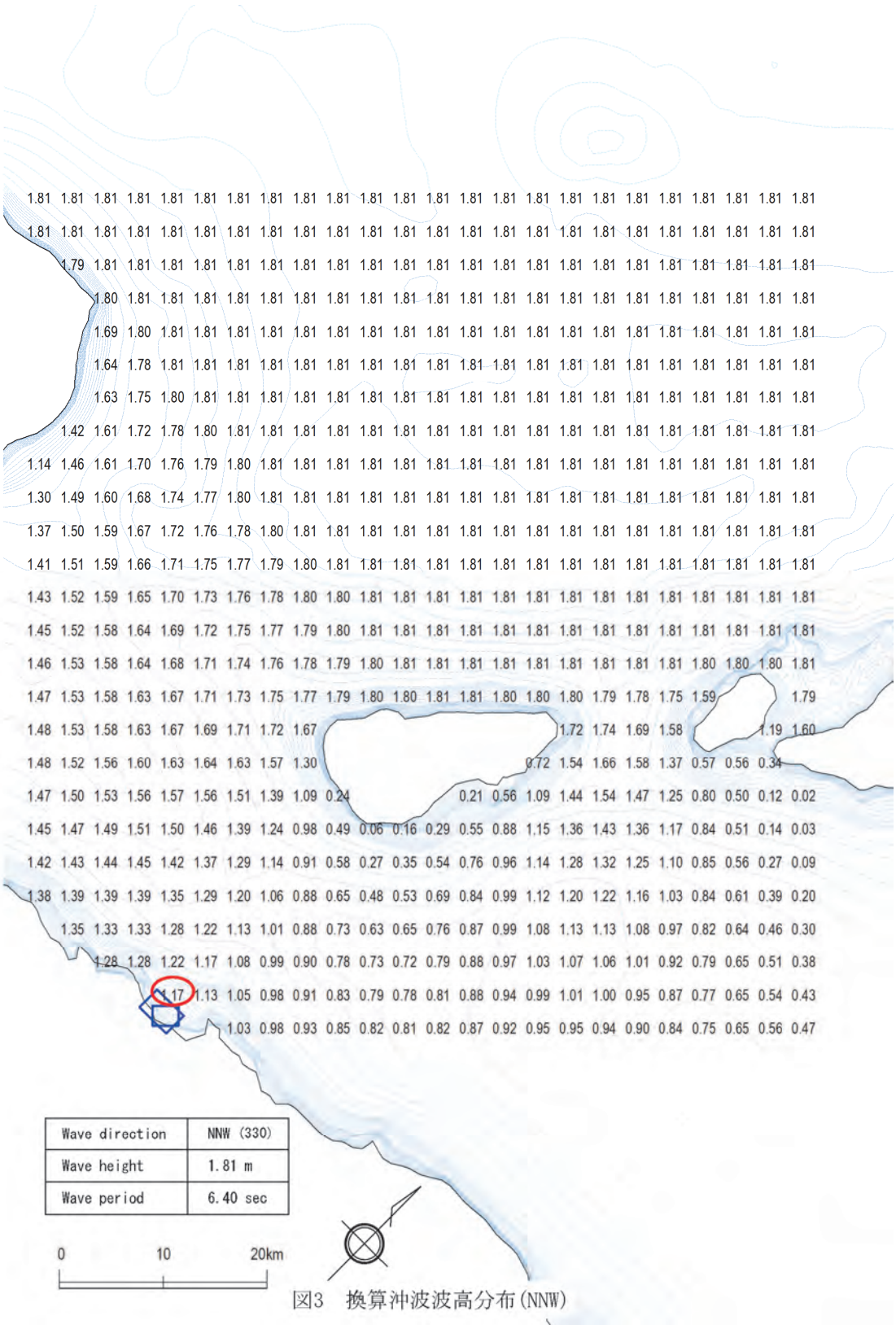
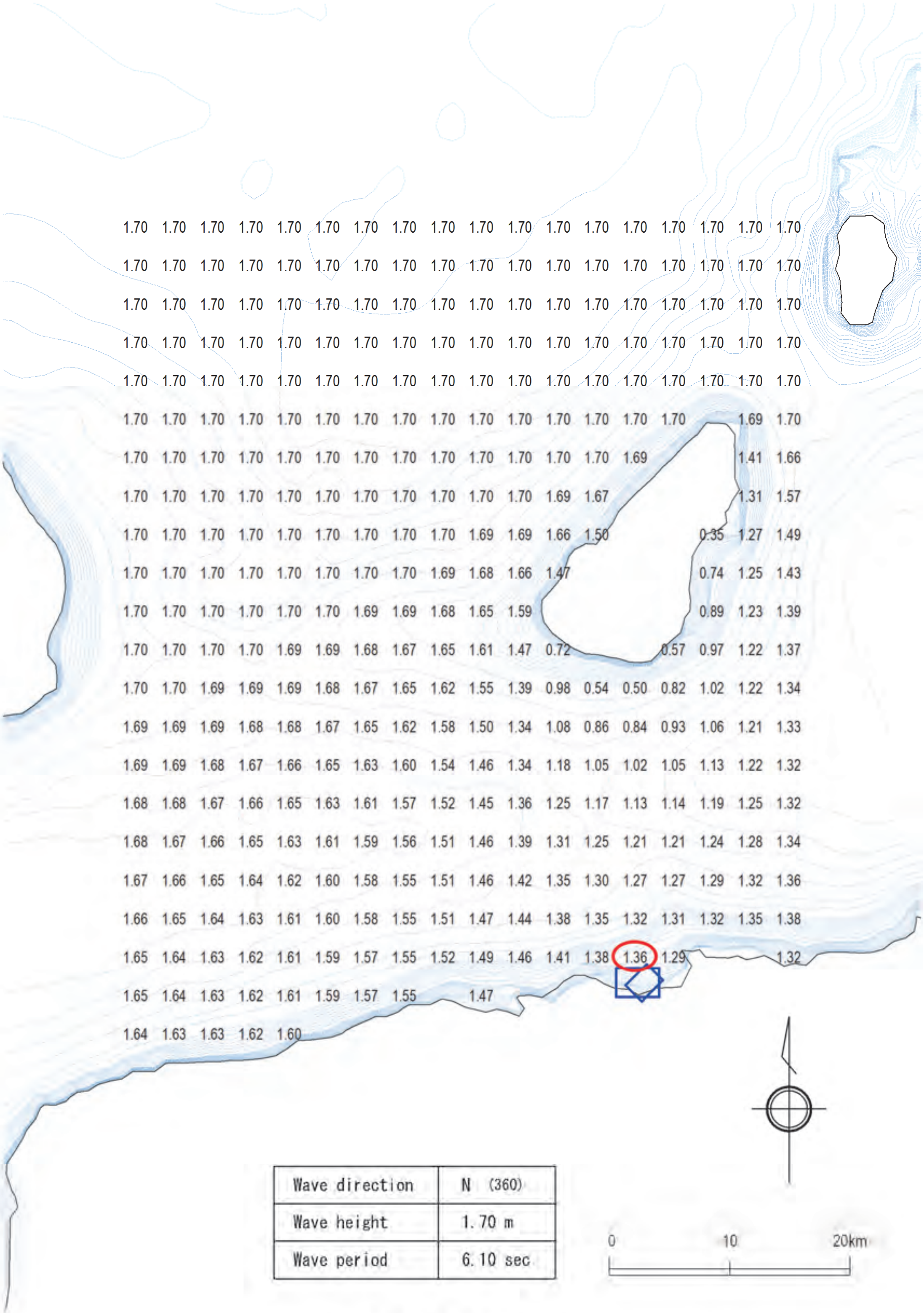


図3　換算沖波波高分布(NNW)



Wave direction	N (360)
Wave height	1.70 m
Wave period	6.10 sec

図4　換算沖波波高分布(N)

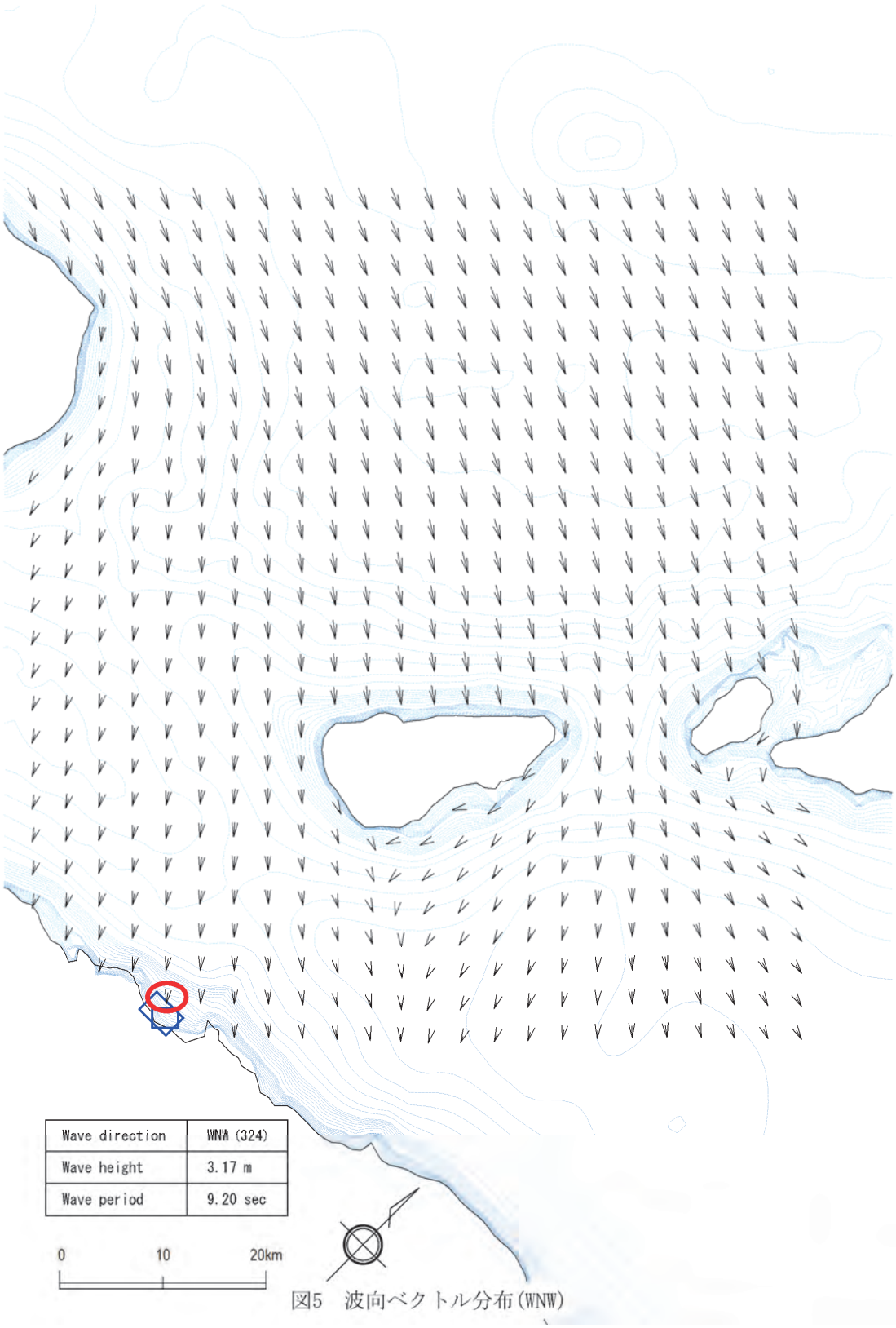


図5　波向ベクトル分布(WNW)

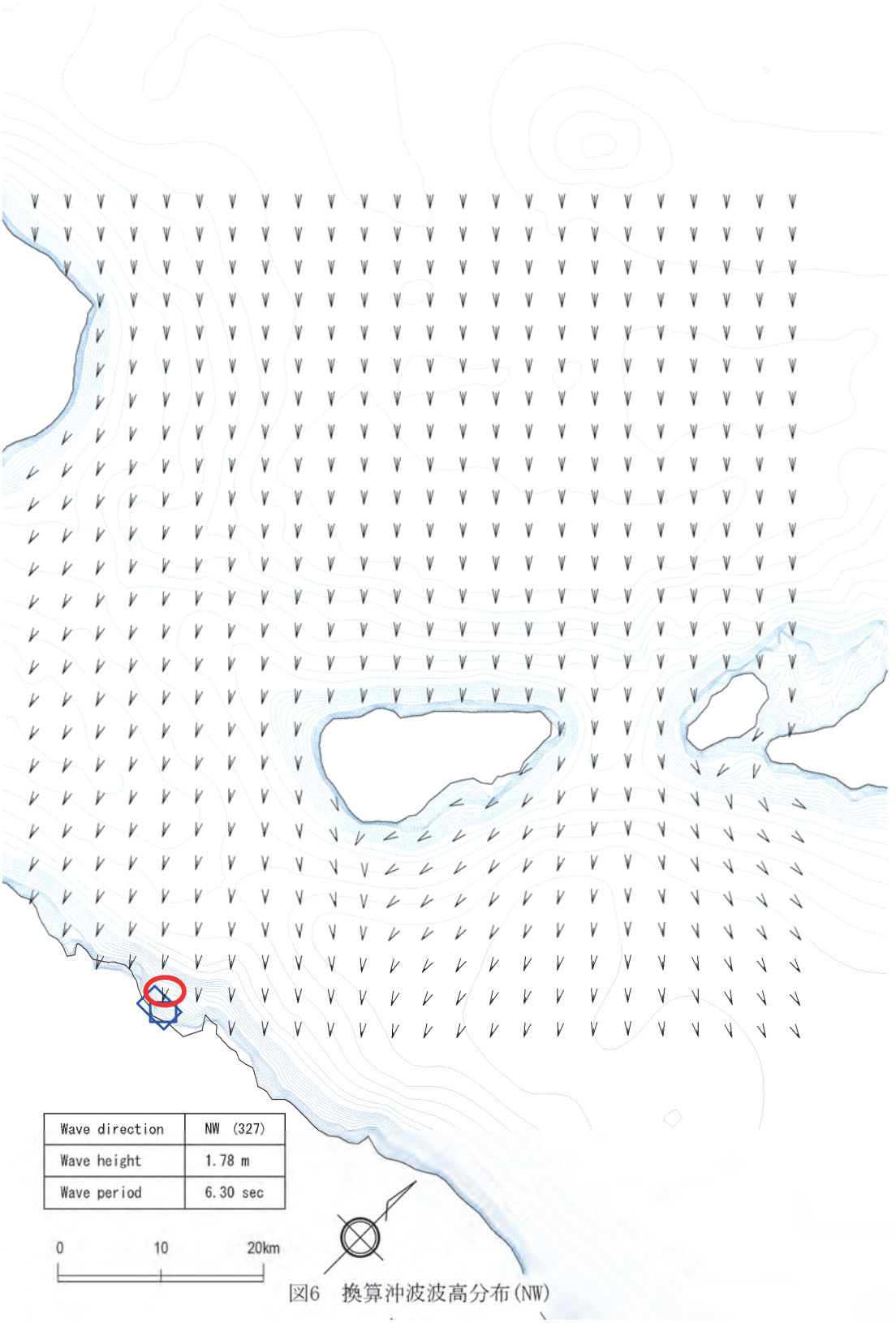


図6　換算沖波波高分布(NW)

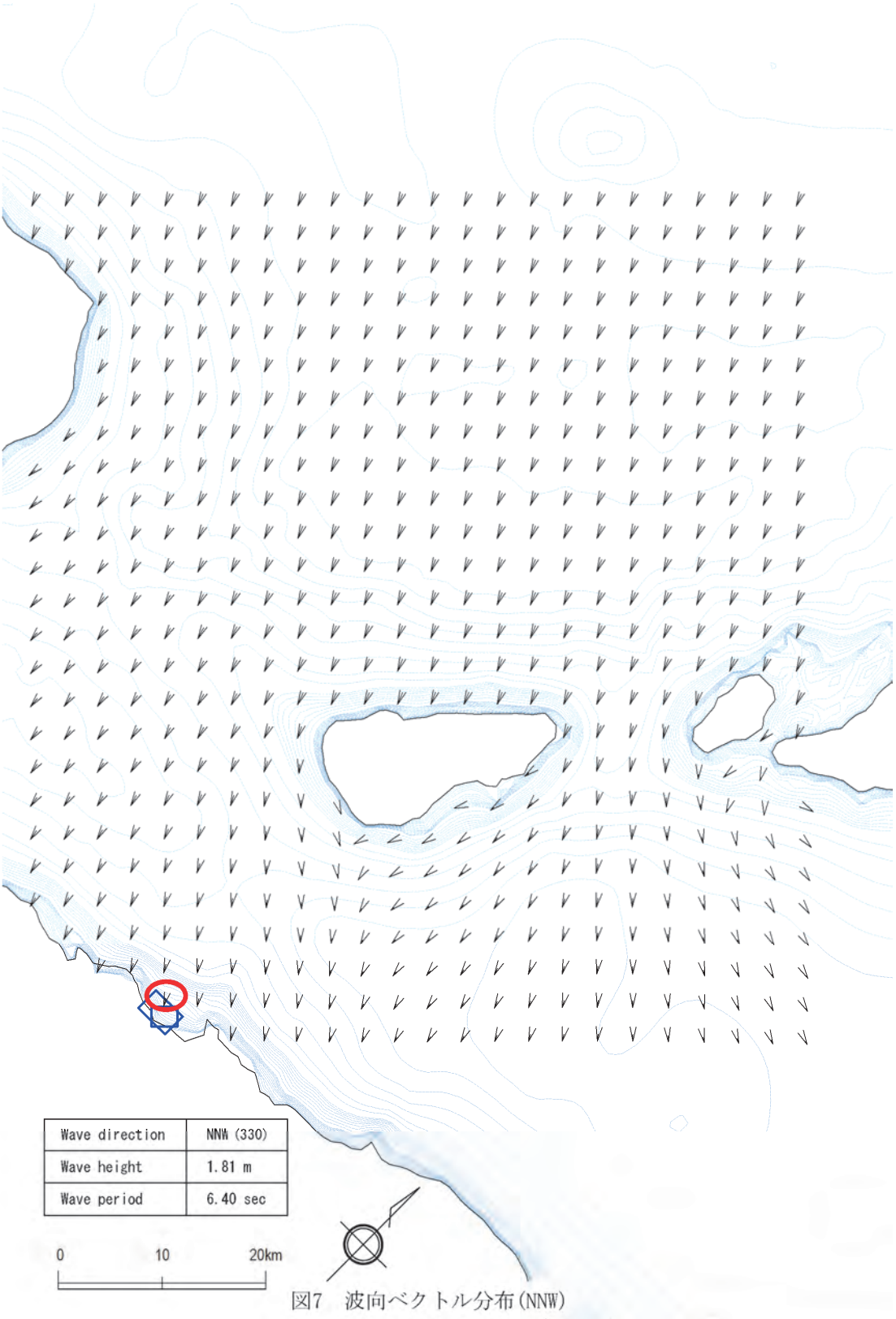


図7　波向ベクトル分布(NNW)

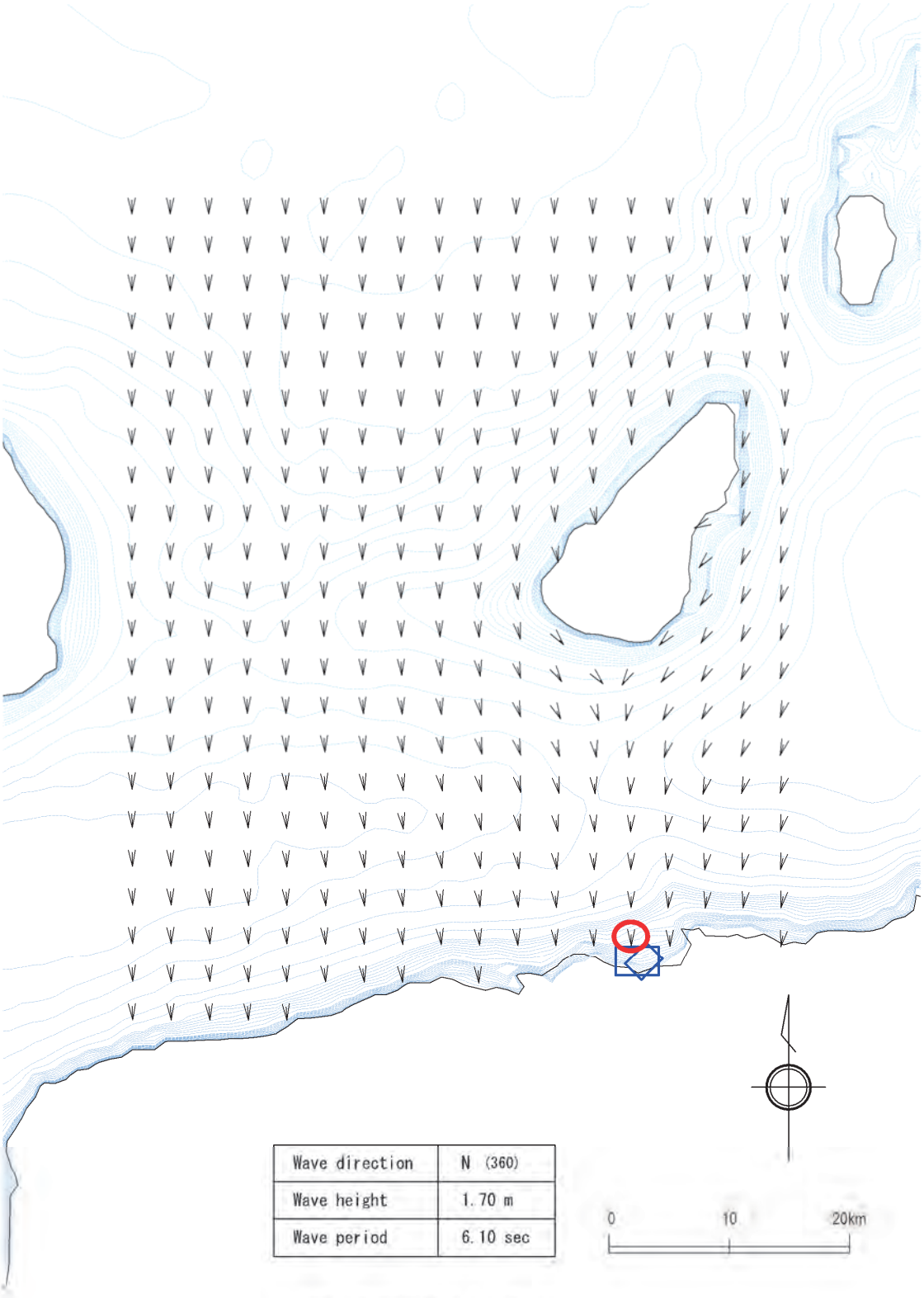


図8　波向ベクトル分布(N)

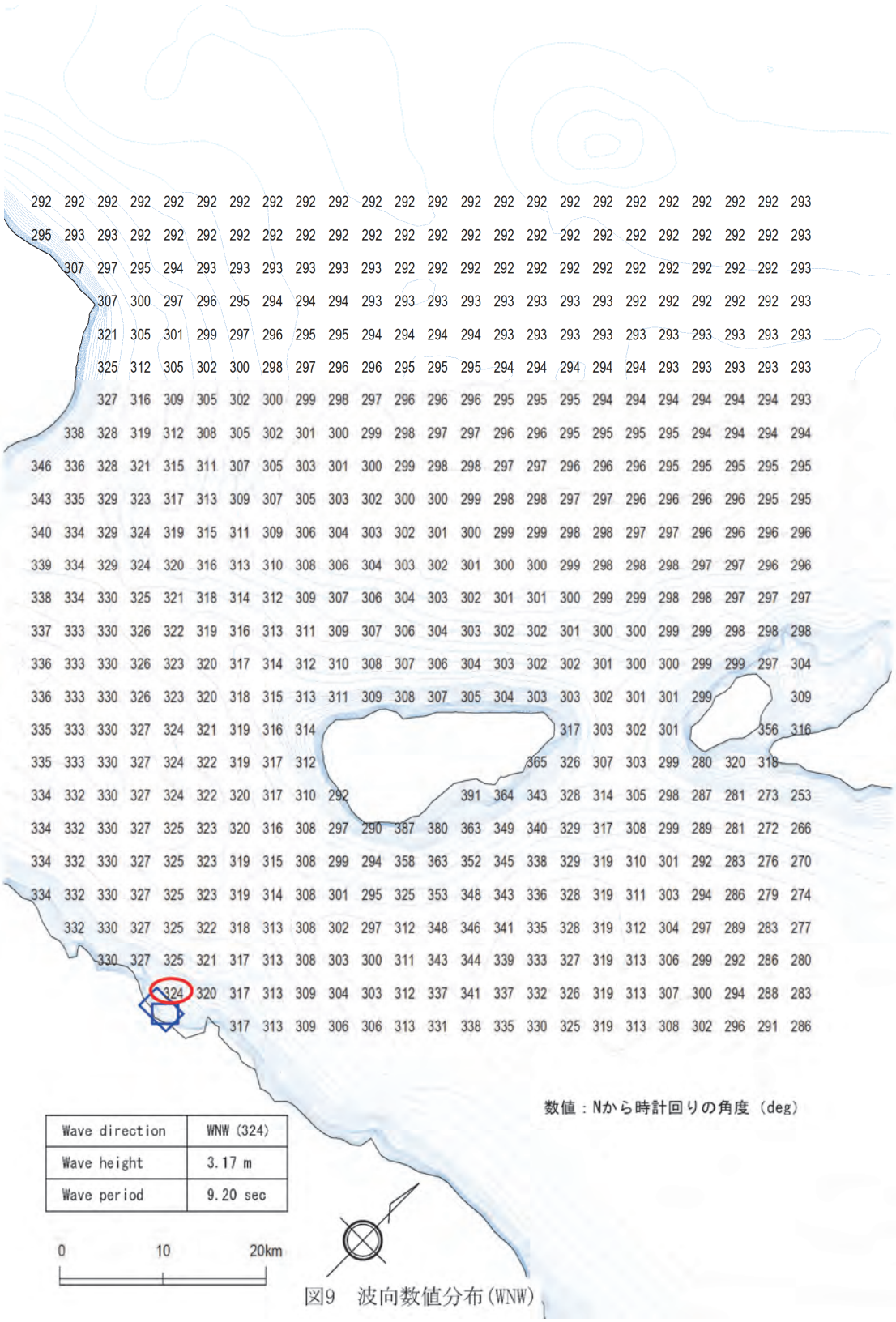


図9　波向数値分布(WNW)

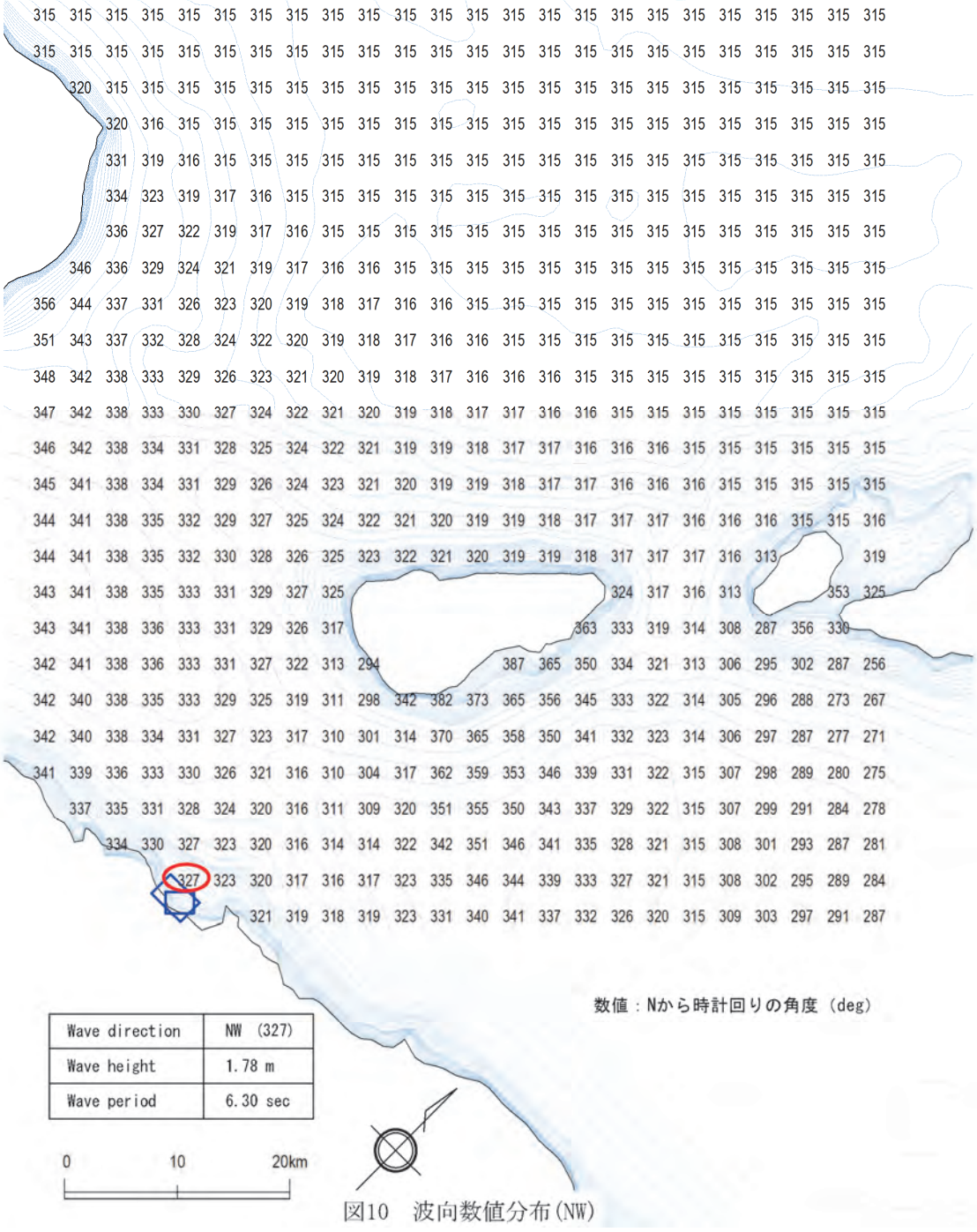


図10　波向数値分布(NW)

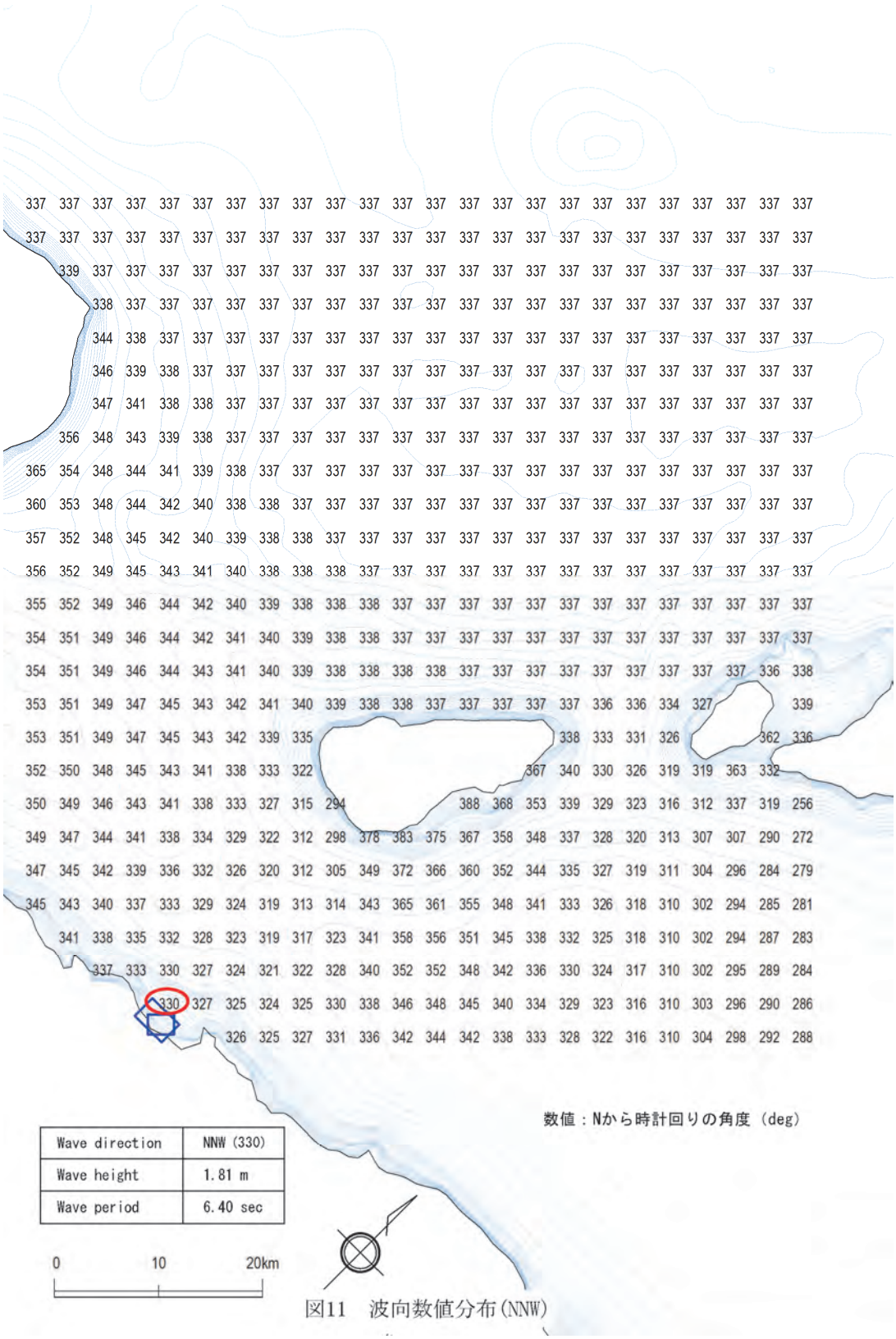


図11　波向数値分布(NNW)

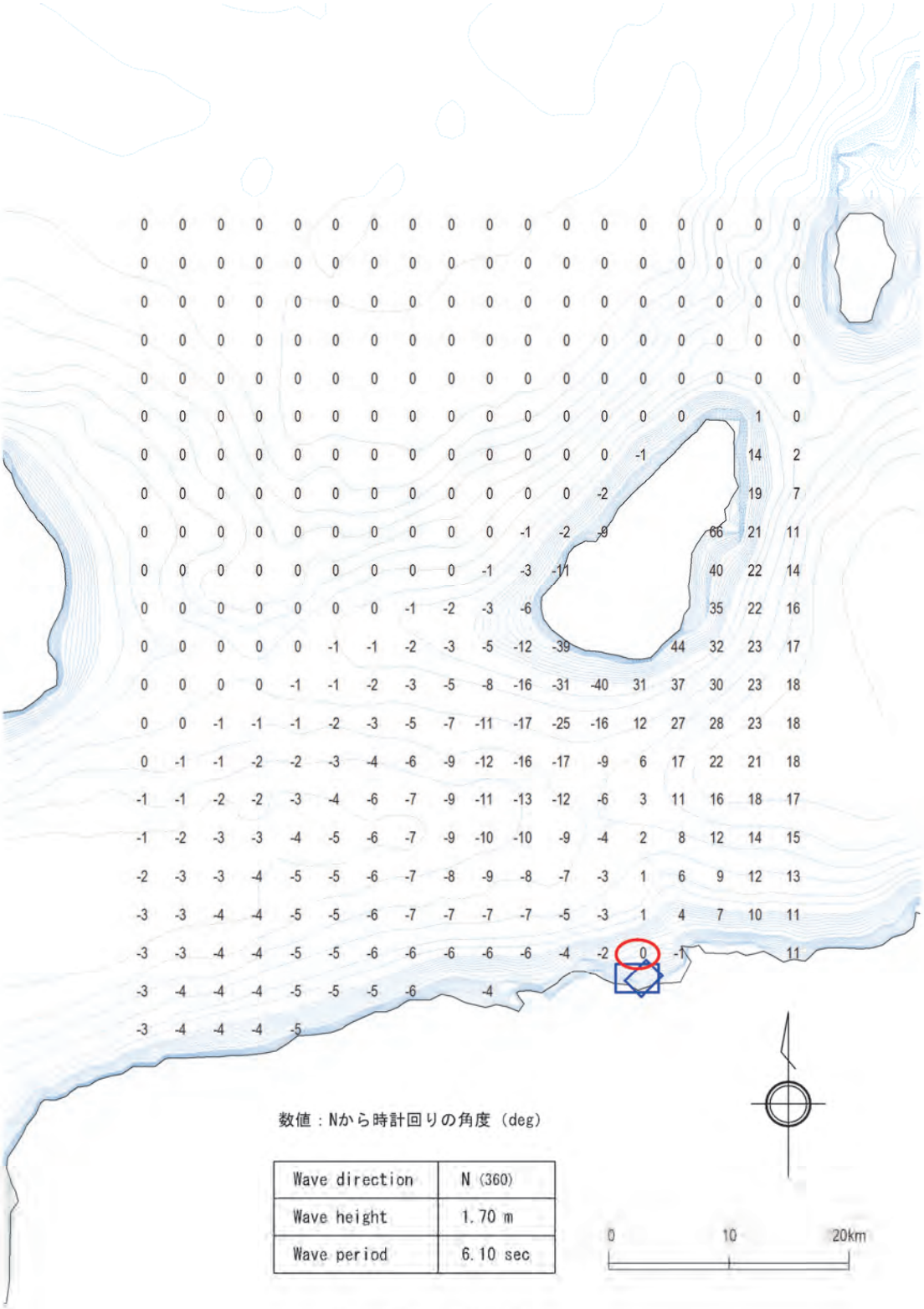

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 -1 14 2
0 0 0 0 0 0 0 0 0 0 0 0 -2 19 7
0 0 0 0 0 0 0 0 0 0 -1 -2 -9 66 21 11
0 0 0 0 0 0 0 0 0 -1 -3 -11 40 22 14
0 0 0 0 0 0 0 -1 -2 -3 -6 35 22 16
0 0 0 0 0 -1 -1 -2 -3 -5 -12 -39 44 32 23 17
0 0 0 0 -1 -1 -2 -3 -5 -8 -16 -31 -40 31 37 30 23 18
0 0 -1 -1 -1 -2 -3 -5 -7 -11 -17 -25 -16 12 27 28 23 18
0 -1 -1 -2 -2 -3 -4 -6 -9 -12 -16 -17 -9 6 17 22 21 18
-1 -1 -2 -2 -3 -4 -6 -7 -9 -11 -13 -12 -6 3 11 16 18 17
-1 -2 -3 -3 -4 -5 -6 -7 -9 -10 -10 -9 -4 2 8 12 14 15
-2 -3 -3 -4 -5 -5 -6 -7 -8 -9 -8 -7 -3 1 6 9 12 13
-3 -3 -4 -4 -5 -5 -6 -7 -7 -7 -7 -5 -3 1 4 7 10 11
-3 -3 -4 -4 -5 -5 -6 -6 -6 -6 -6 -4 -2 0 -1 11
-3 -4 -4 -4 -5 -5 -5 -6 -4
-3 -4 -4 -4 -5
数値：Nから時計回りの角度（deg）
Wave direction N (360)
Wave height 1.70 m
Wave period 6.10 sec
0 10 20km

図12　波向数値分布(N)

付属資料５　対象地点の設計波計算結果

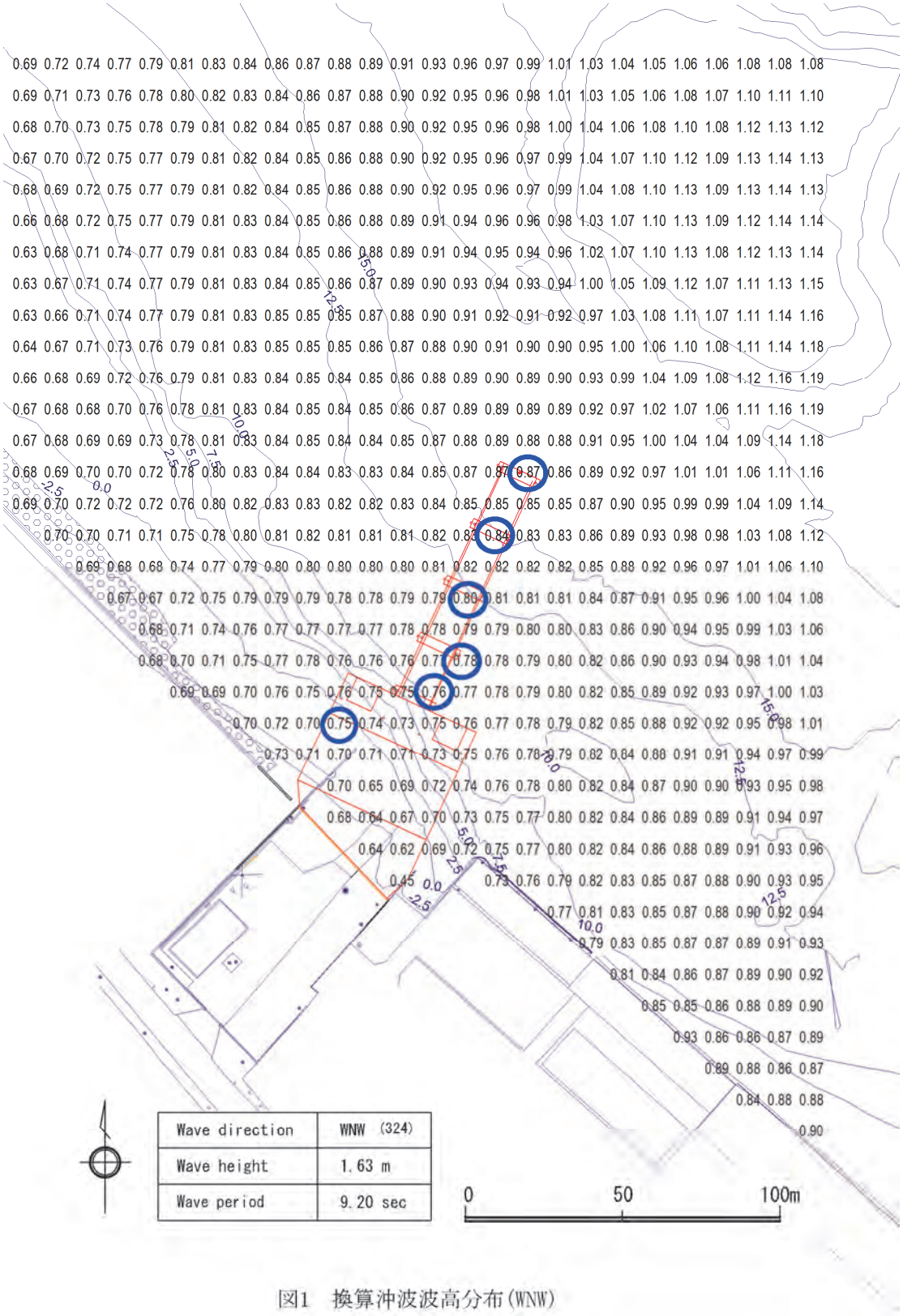


図1　換算沖波波高分布(WNW)

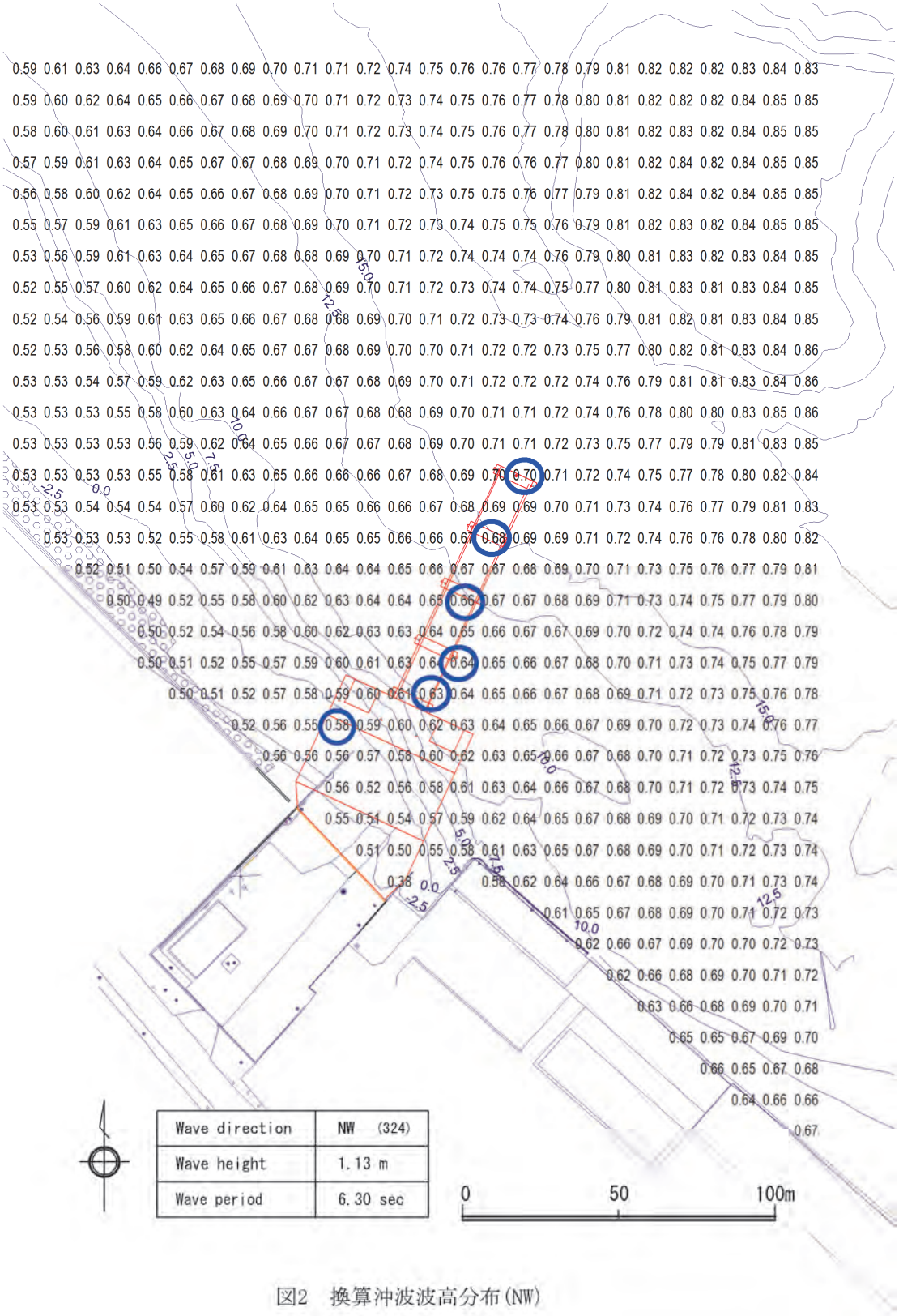


図2　換算沖波波高分布(NW)

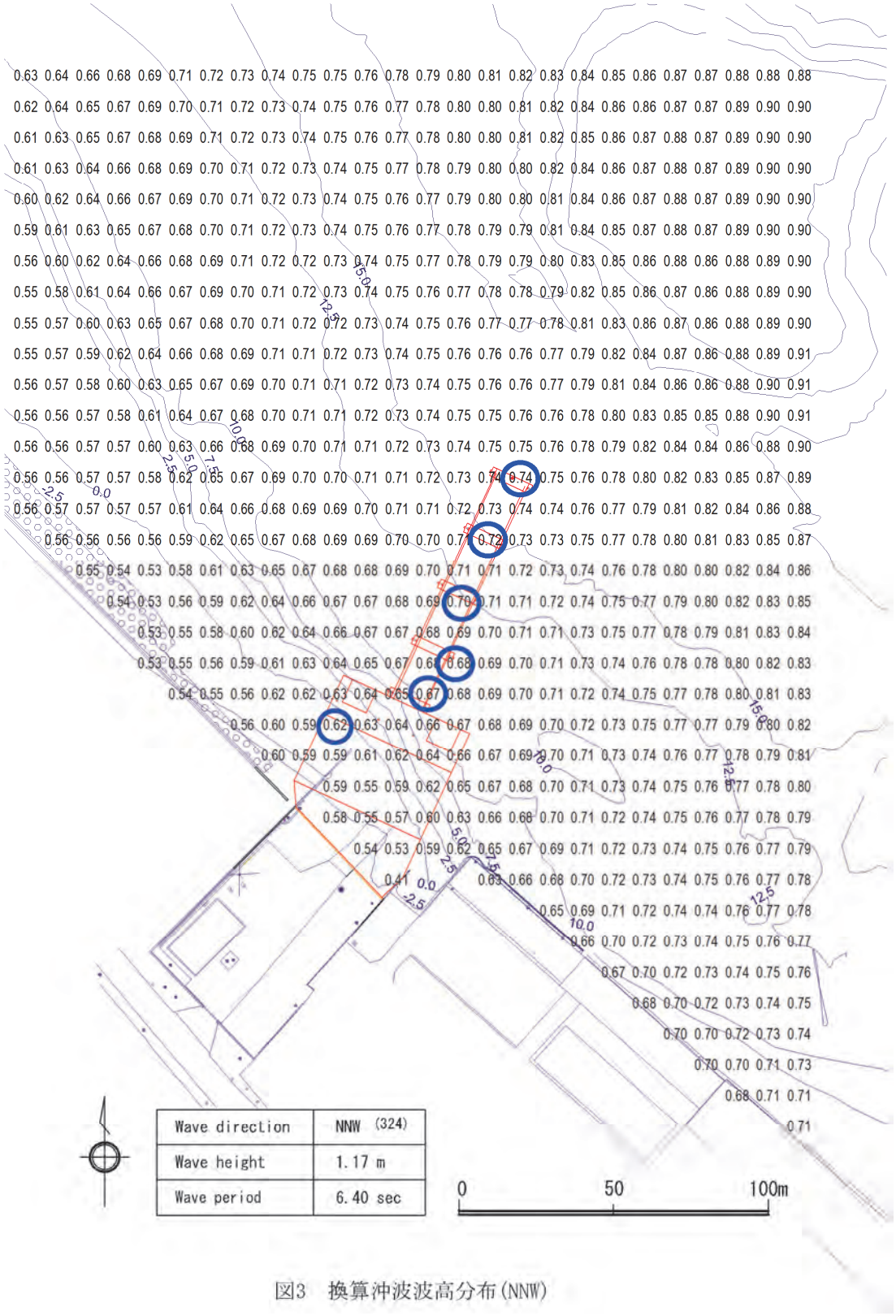


図3　換算沖波波高分布(NNW)

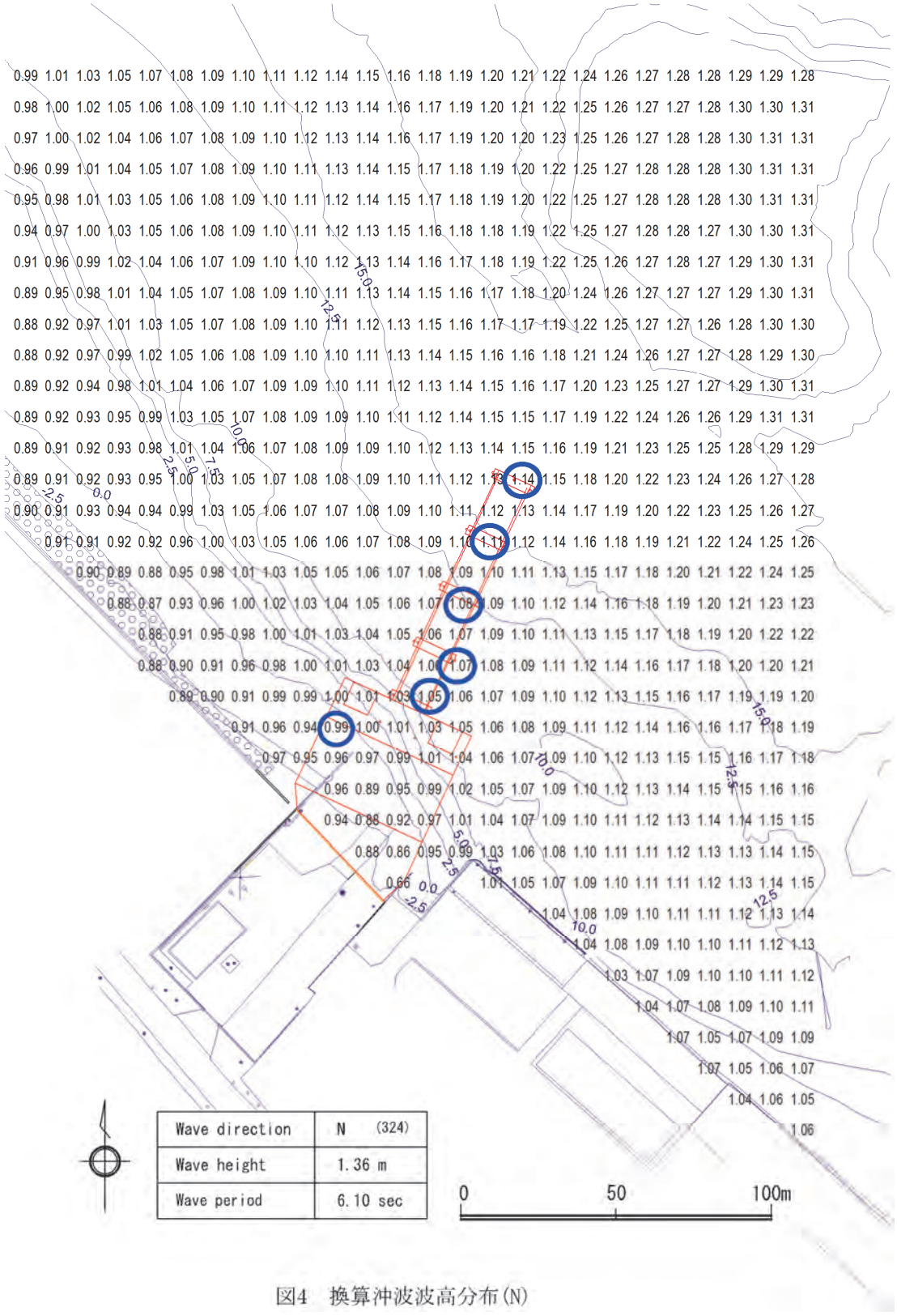


図4　換算沖波波高分布(N)

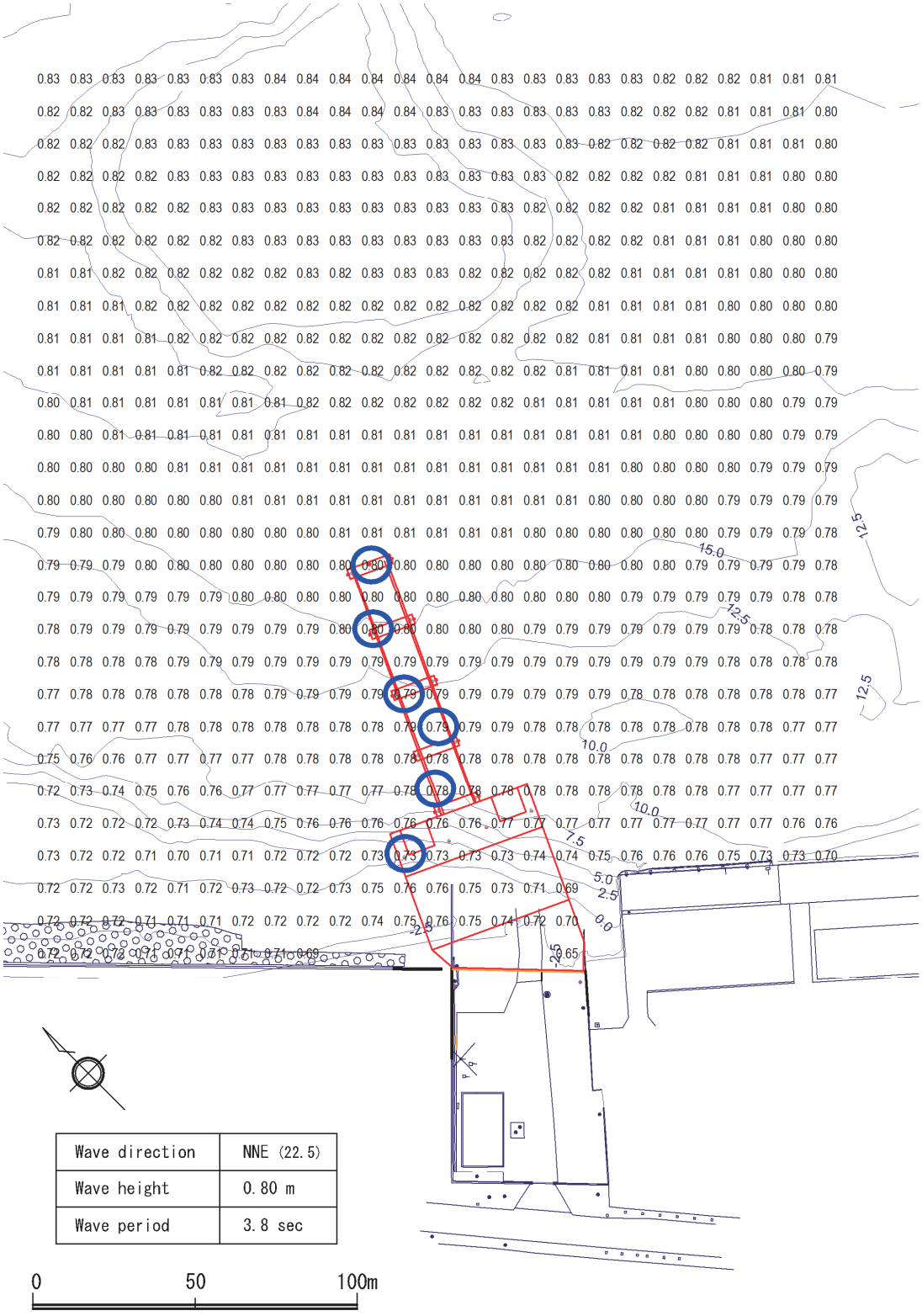


図5　換算沖波波高分布(NNE)

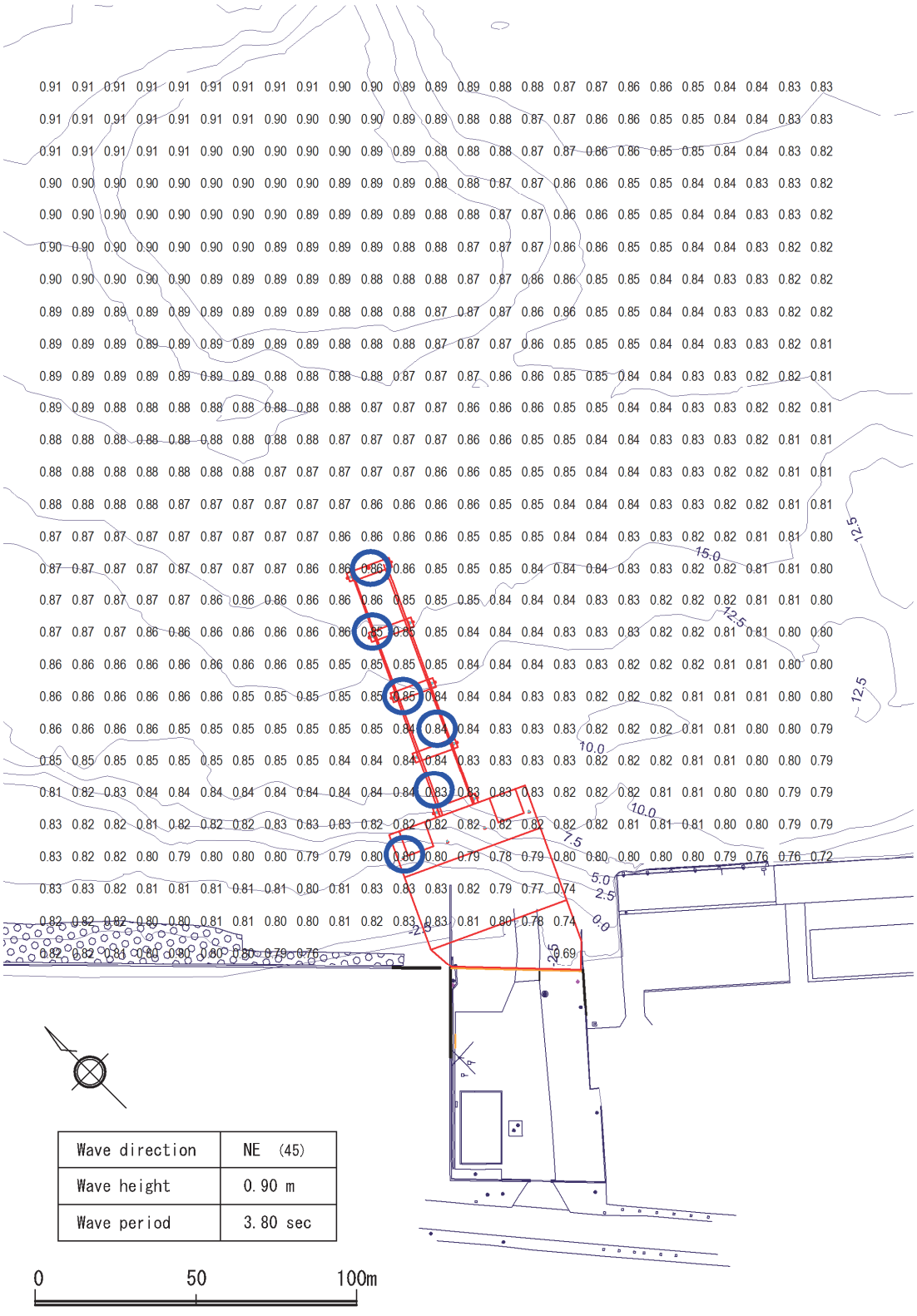


図6　換算沖波波高分布(NE)

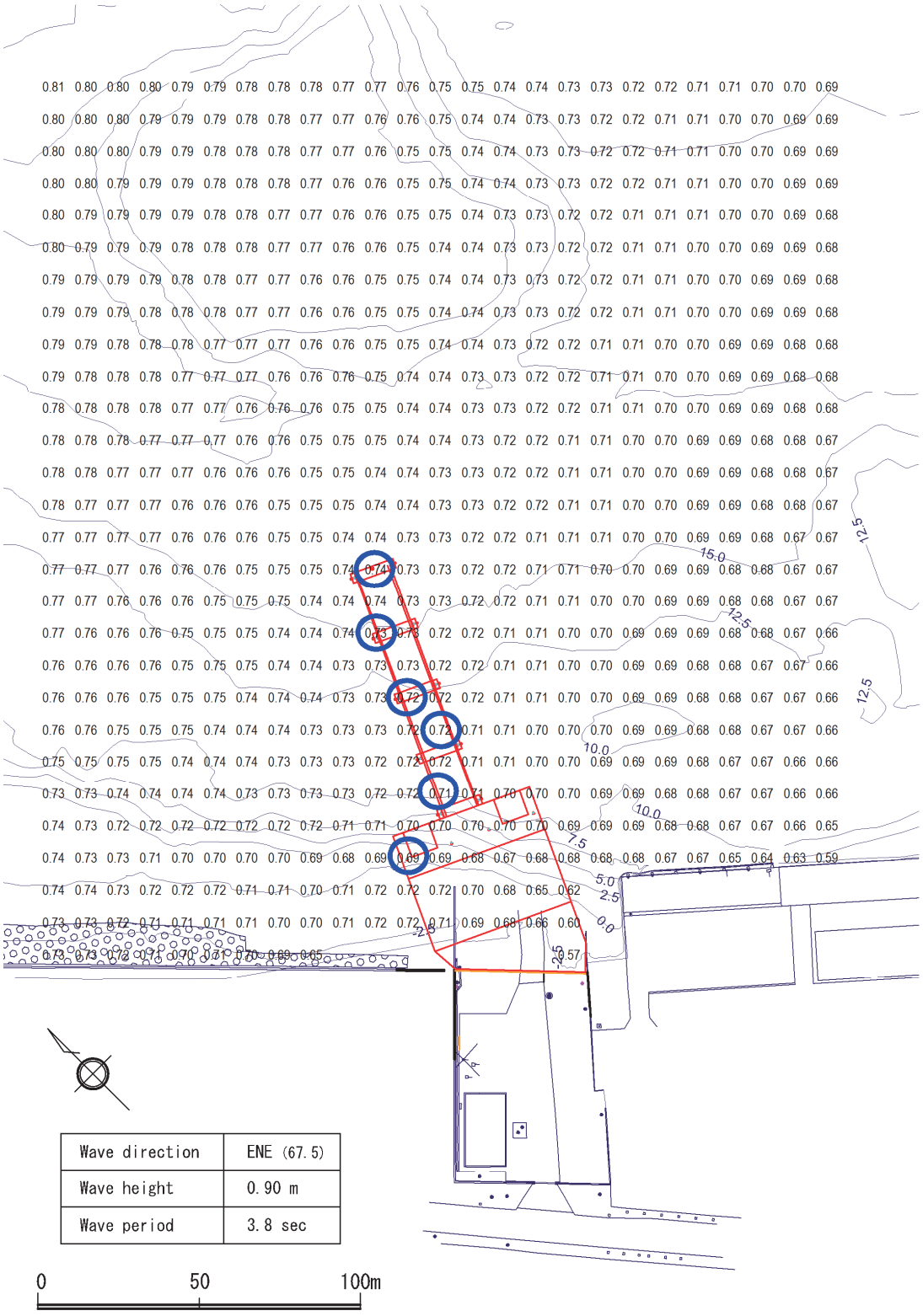


図7　換算沖波波高分布(ENE)

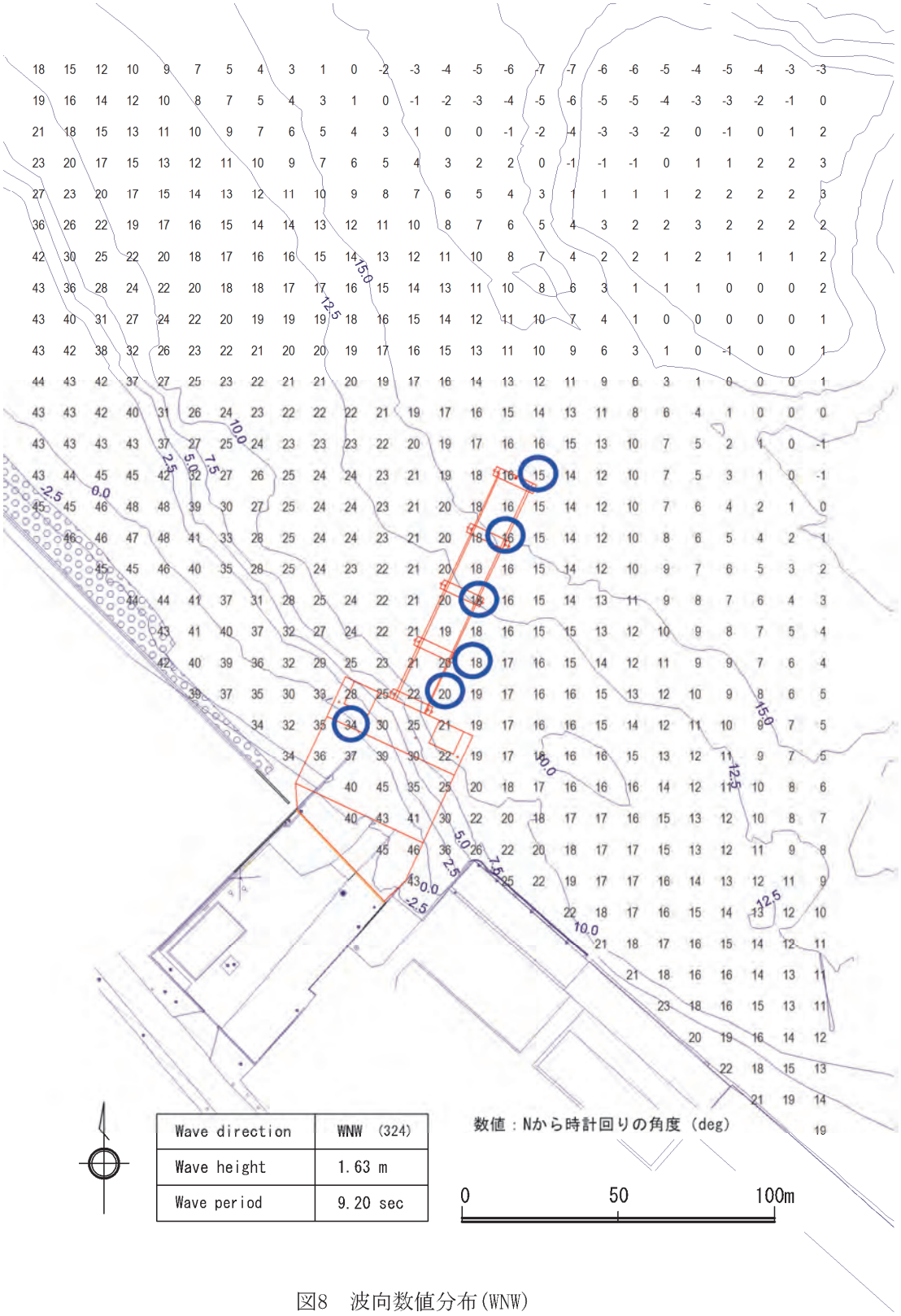


図8　波向数値分布(WNW)

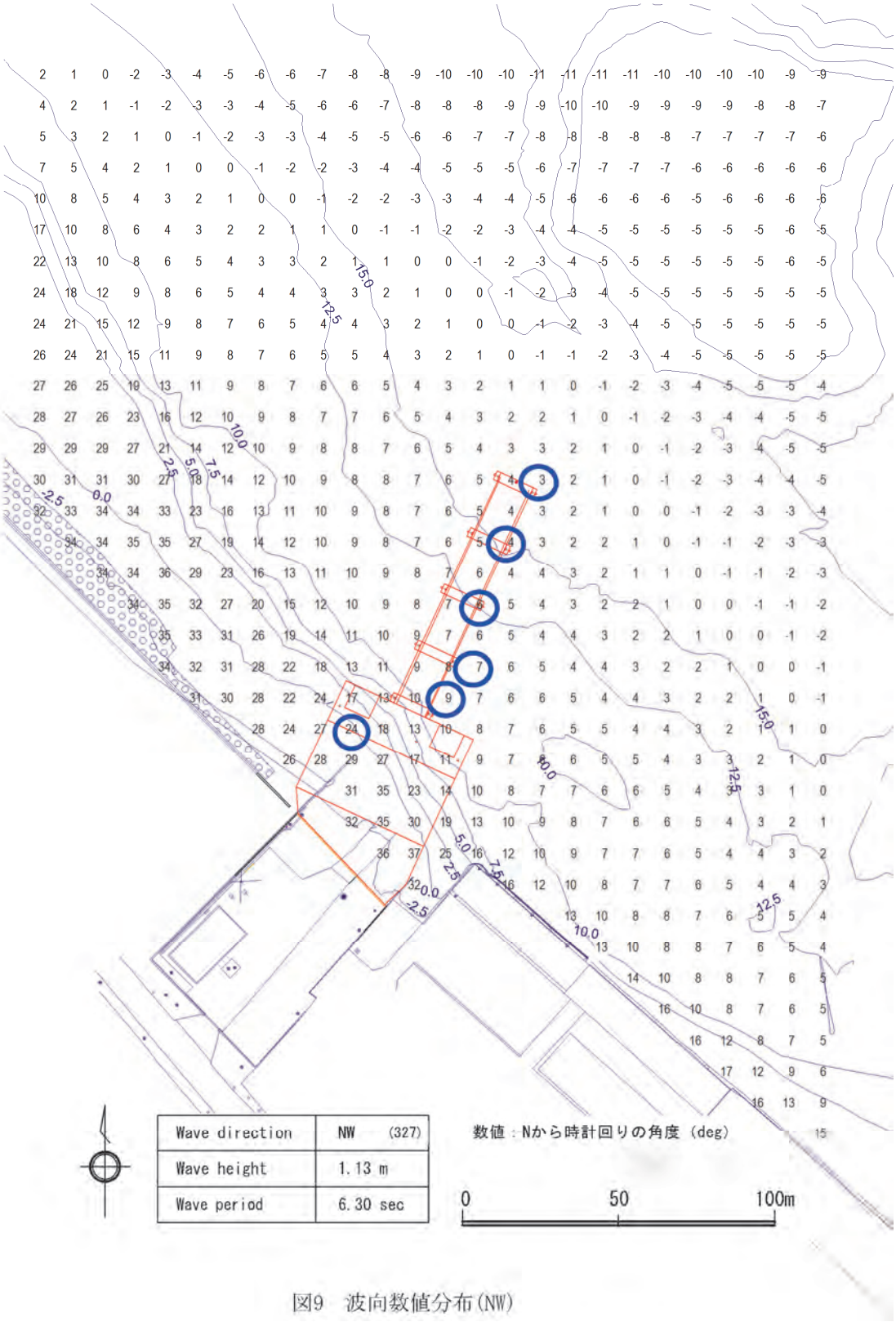

Wave direction NW (327)
Wave height 1.13 m
Wave period 6.30 sec
数値：Nから時計回りの角度（deg）
0
50
100m

図9　波向数値分布(NW)

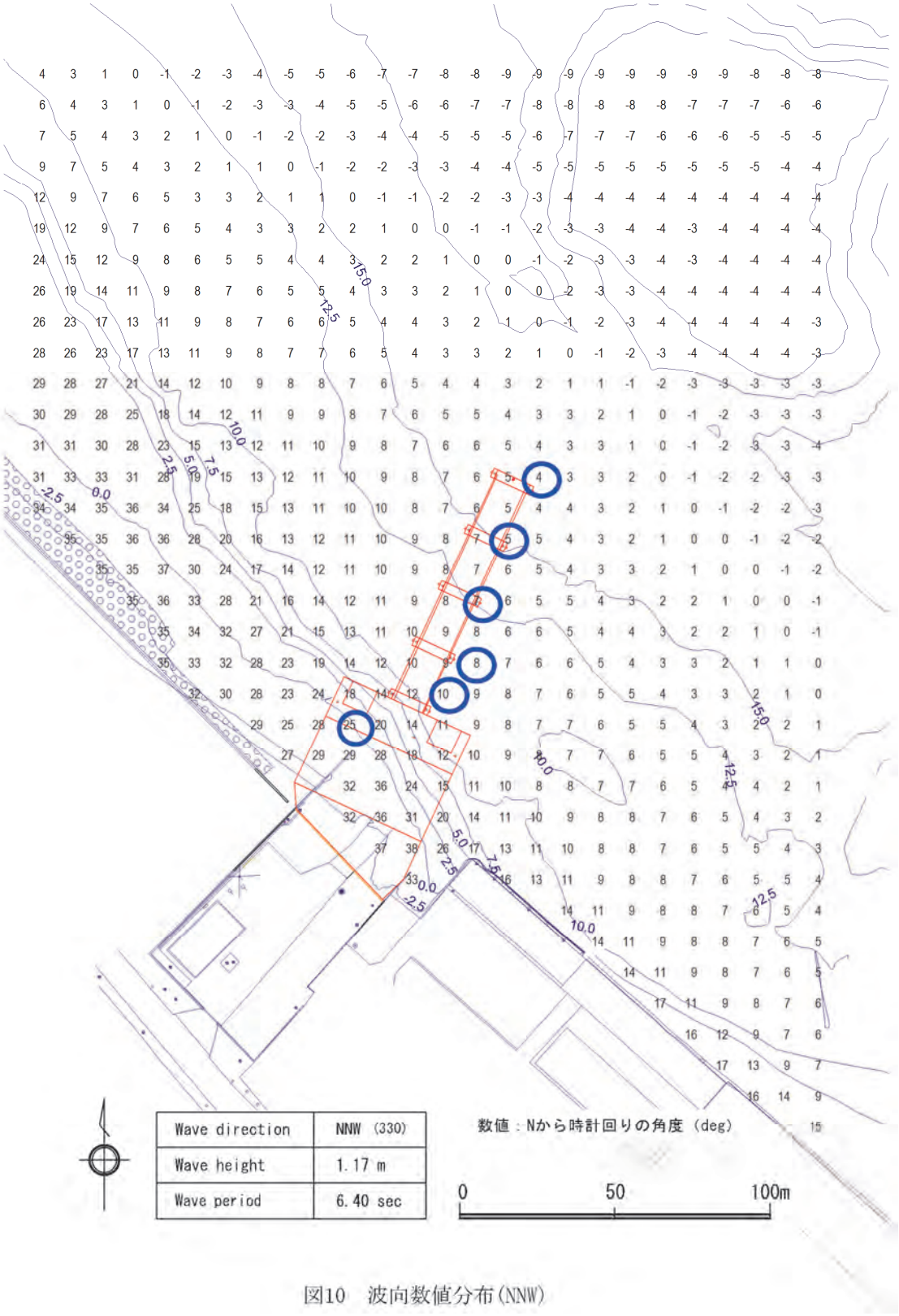


図10　波向数値分布(NNW)

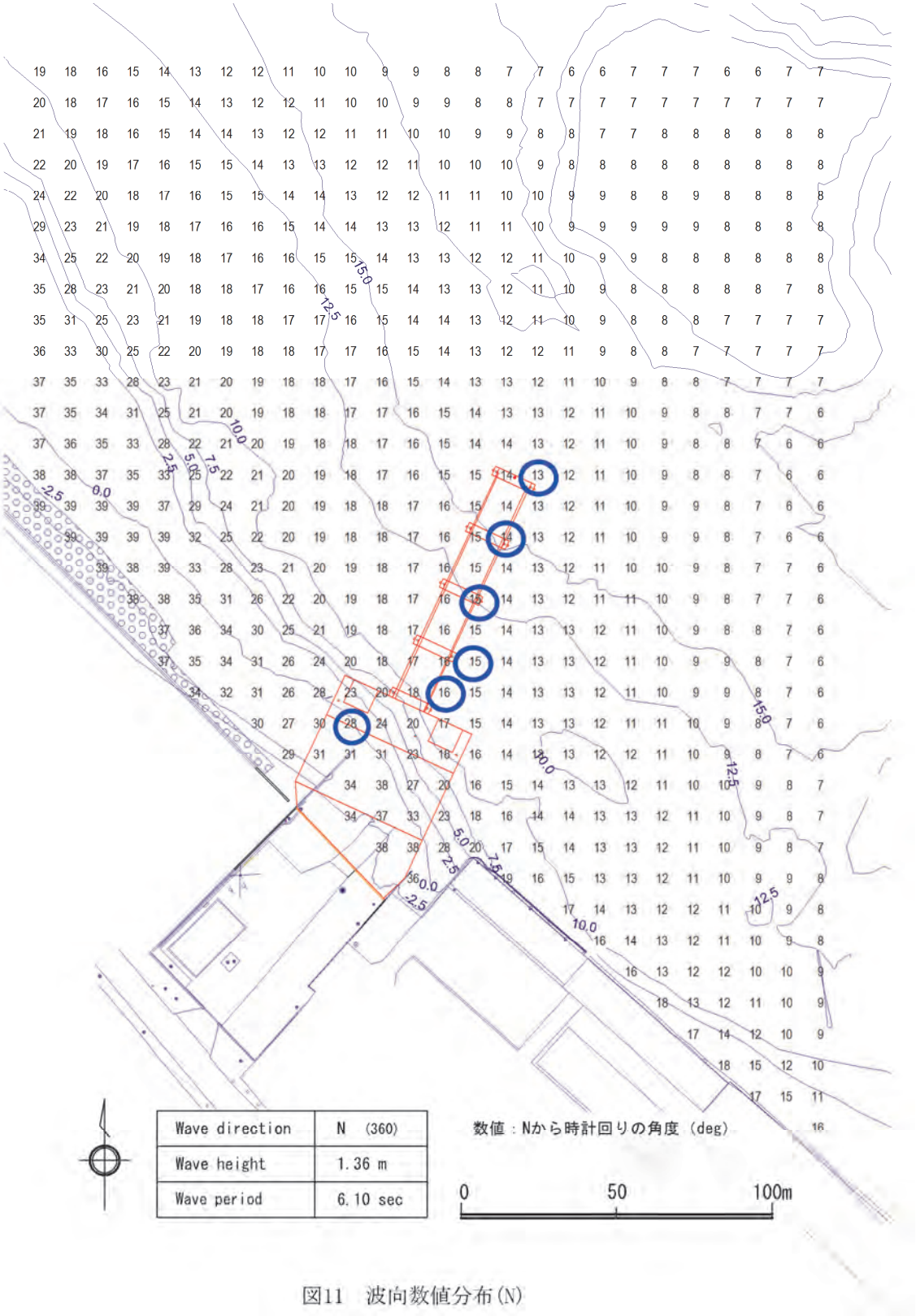

Wave direction N (360)
Wave height 1.36 m
Wave period 6.10 sec
数値：Nから時計回りの角度（deg）
0
50
100m

図11　波向数値分布(N)

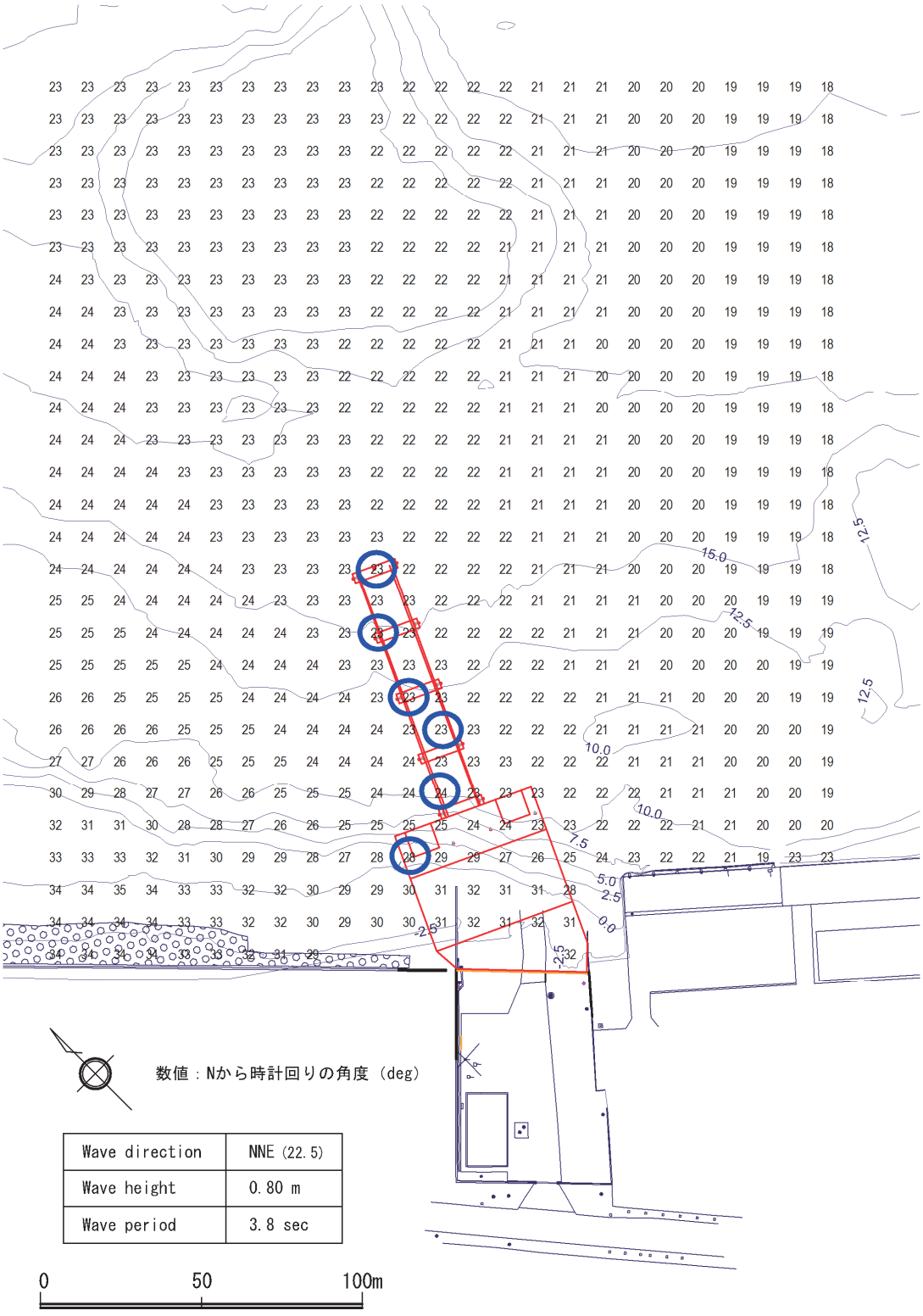


図12　波向数値分布(NNE)

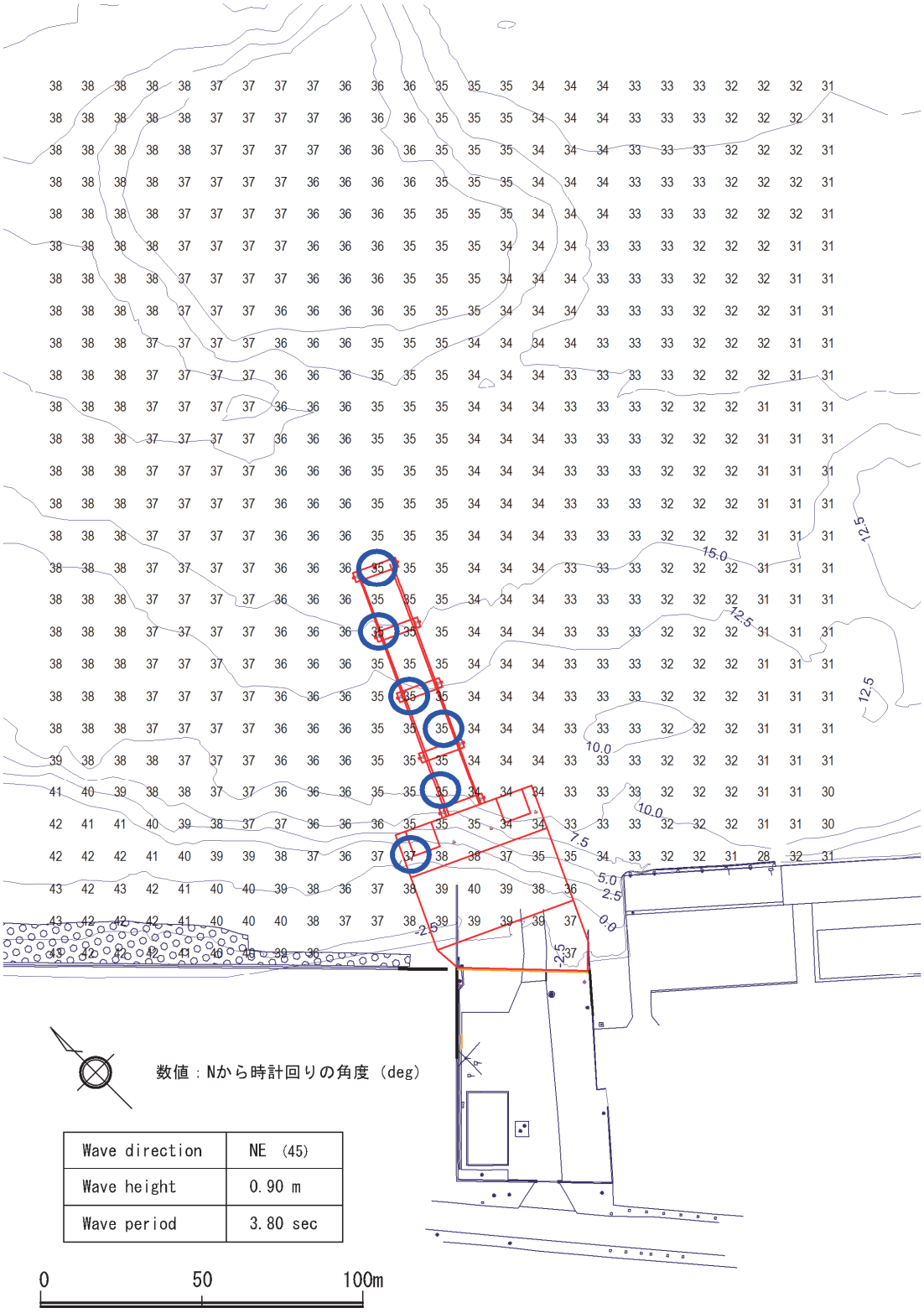


図13　波向数値分布(NE)

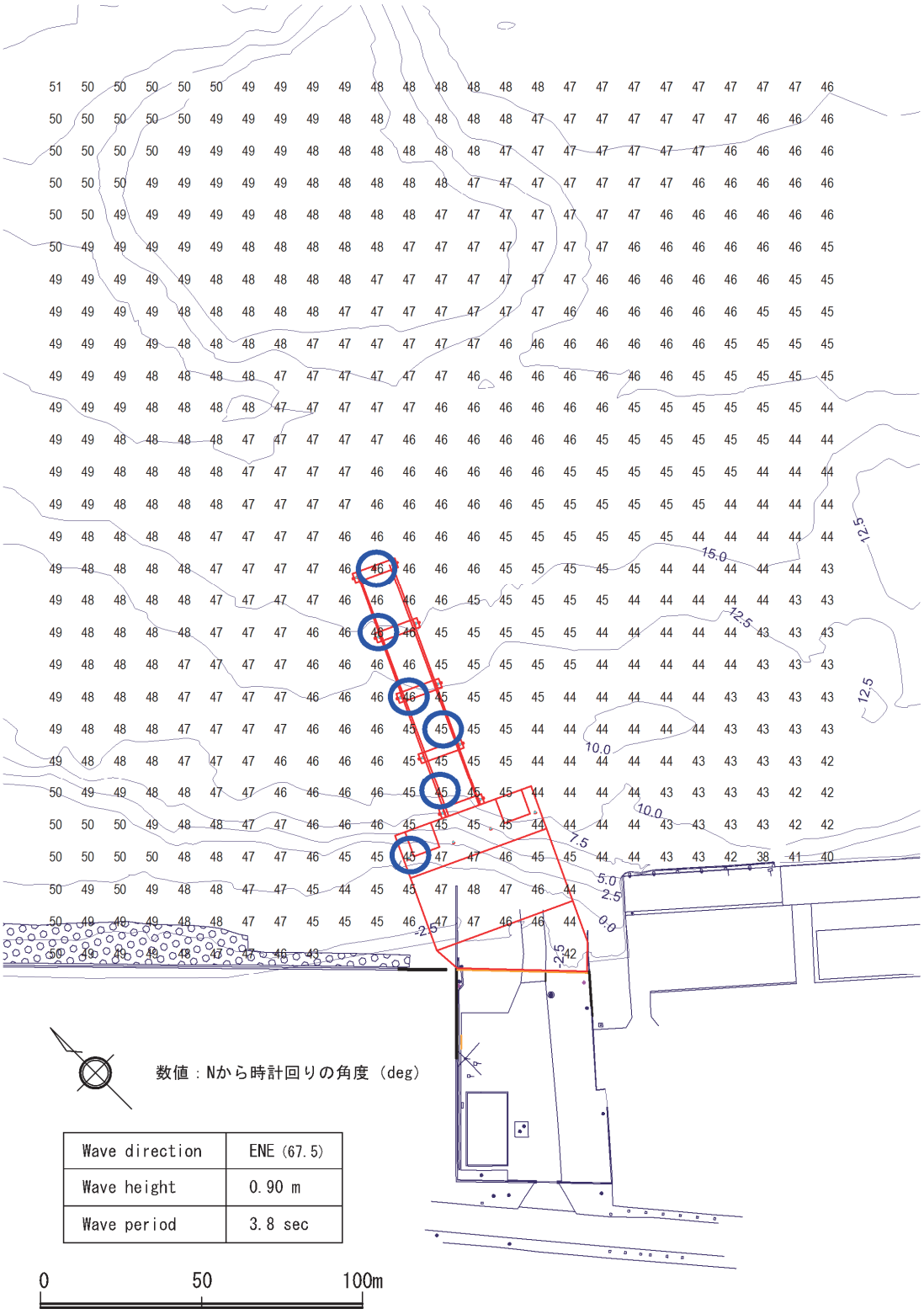


図14　波向数値分布(ENE)

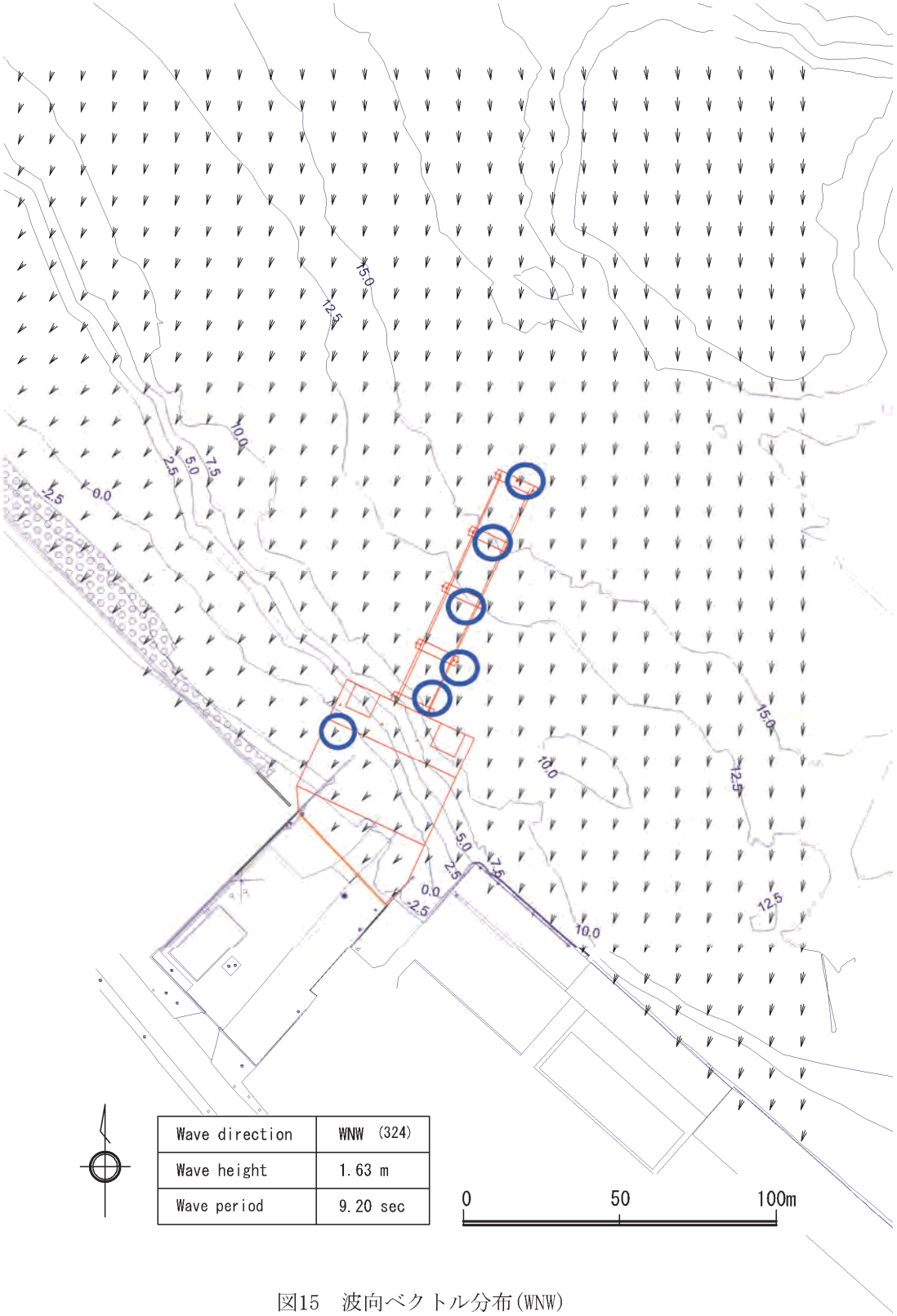


図15　波向ベクトル分布(WNW)

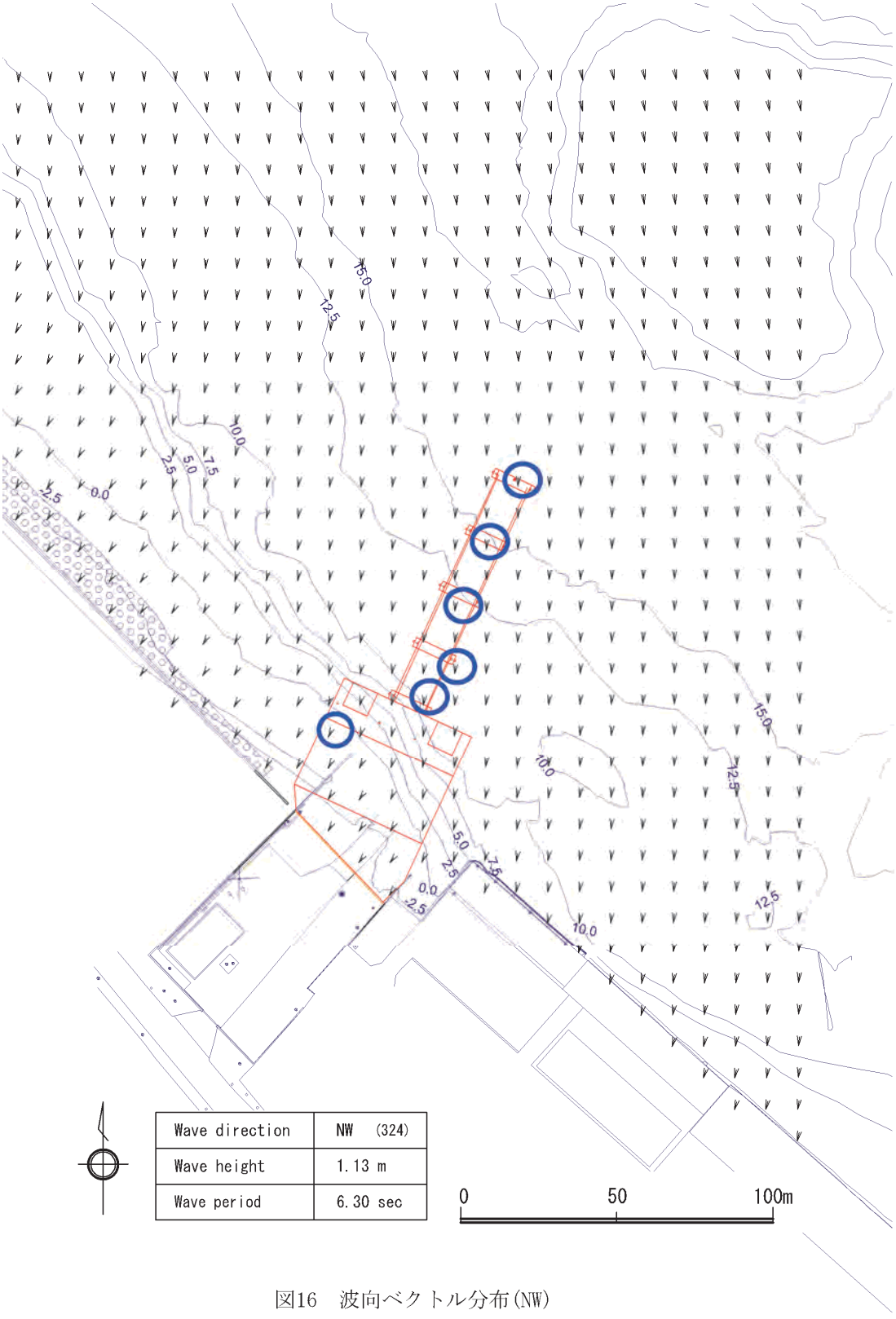


図16　波向ベクトル分布(NW)

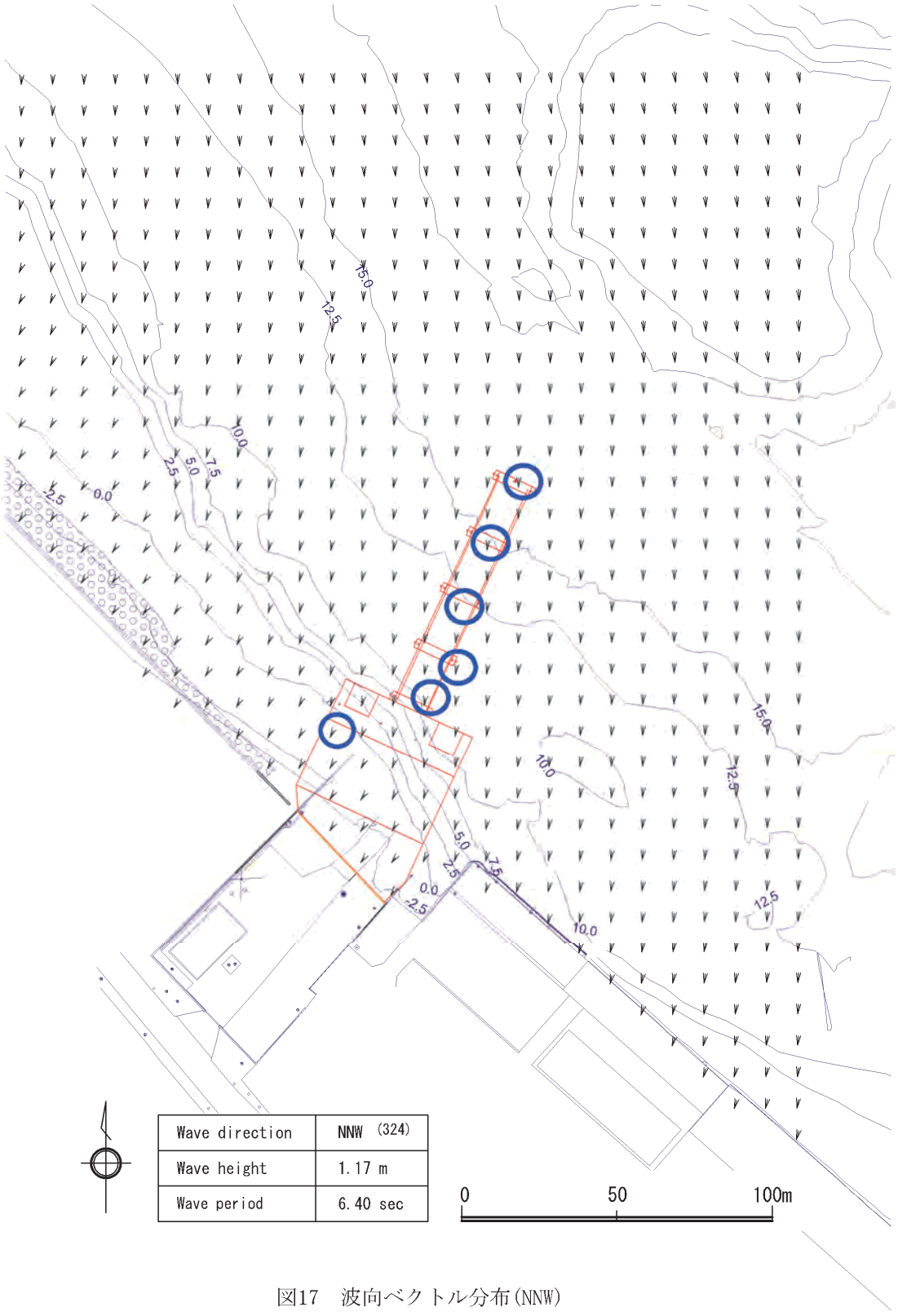


図17　波向ベクトル分布(NNW)

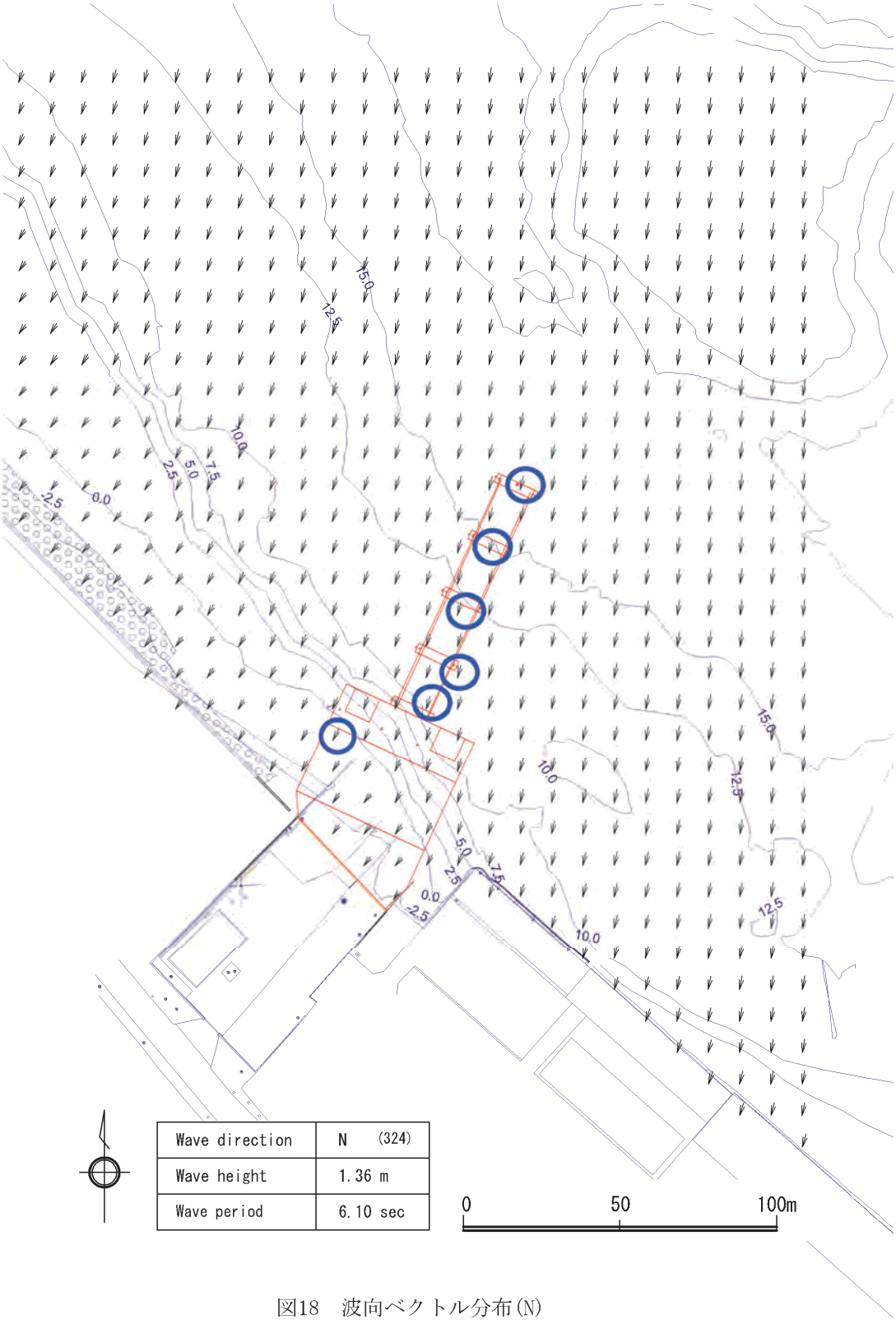


図18　波向ベクトル分布(N)

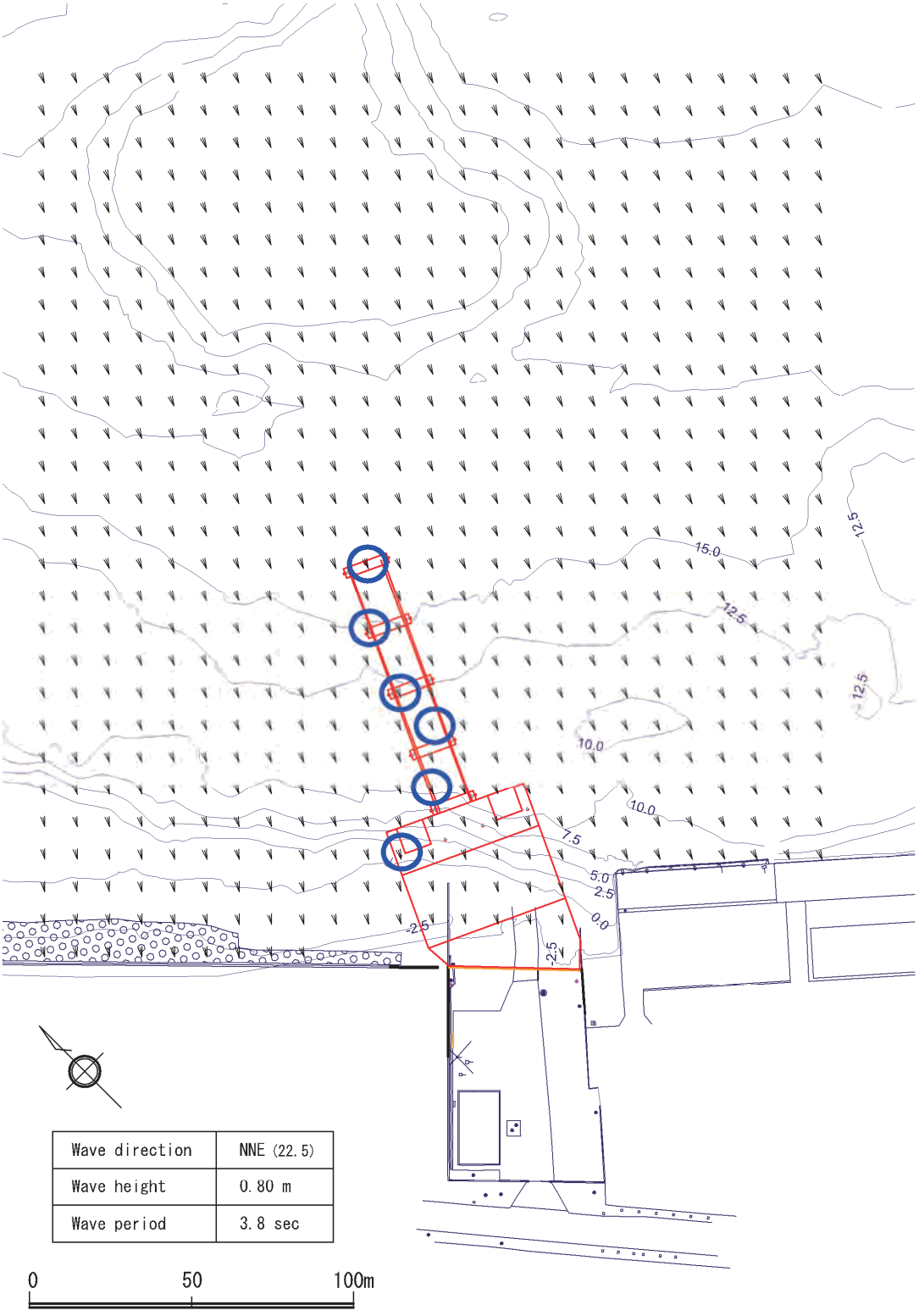


図19　波向ベクトル分布(NNE)

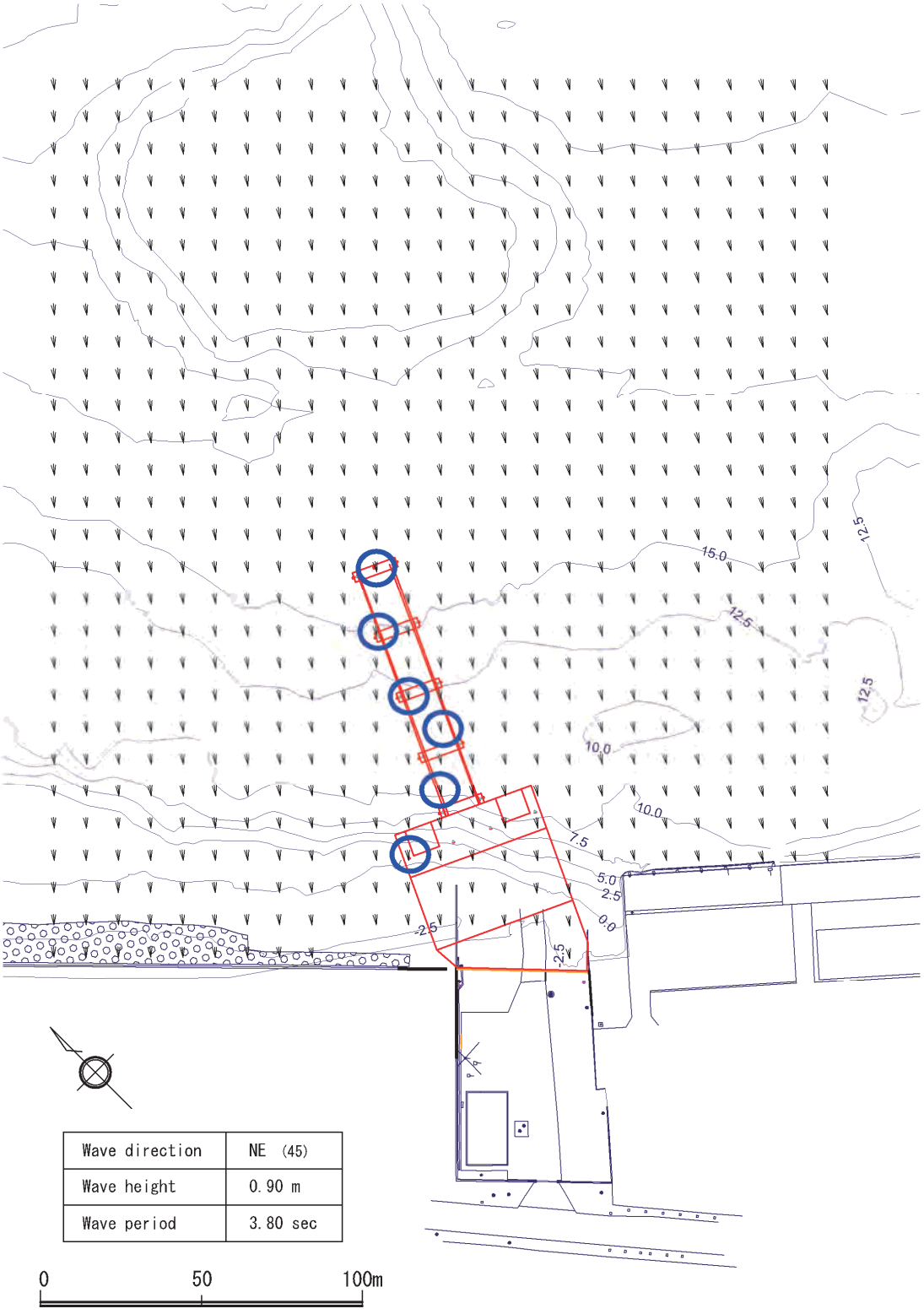


図20　波向ベクトル分布(NE)

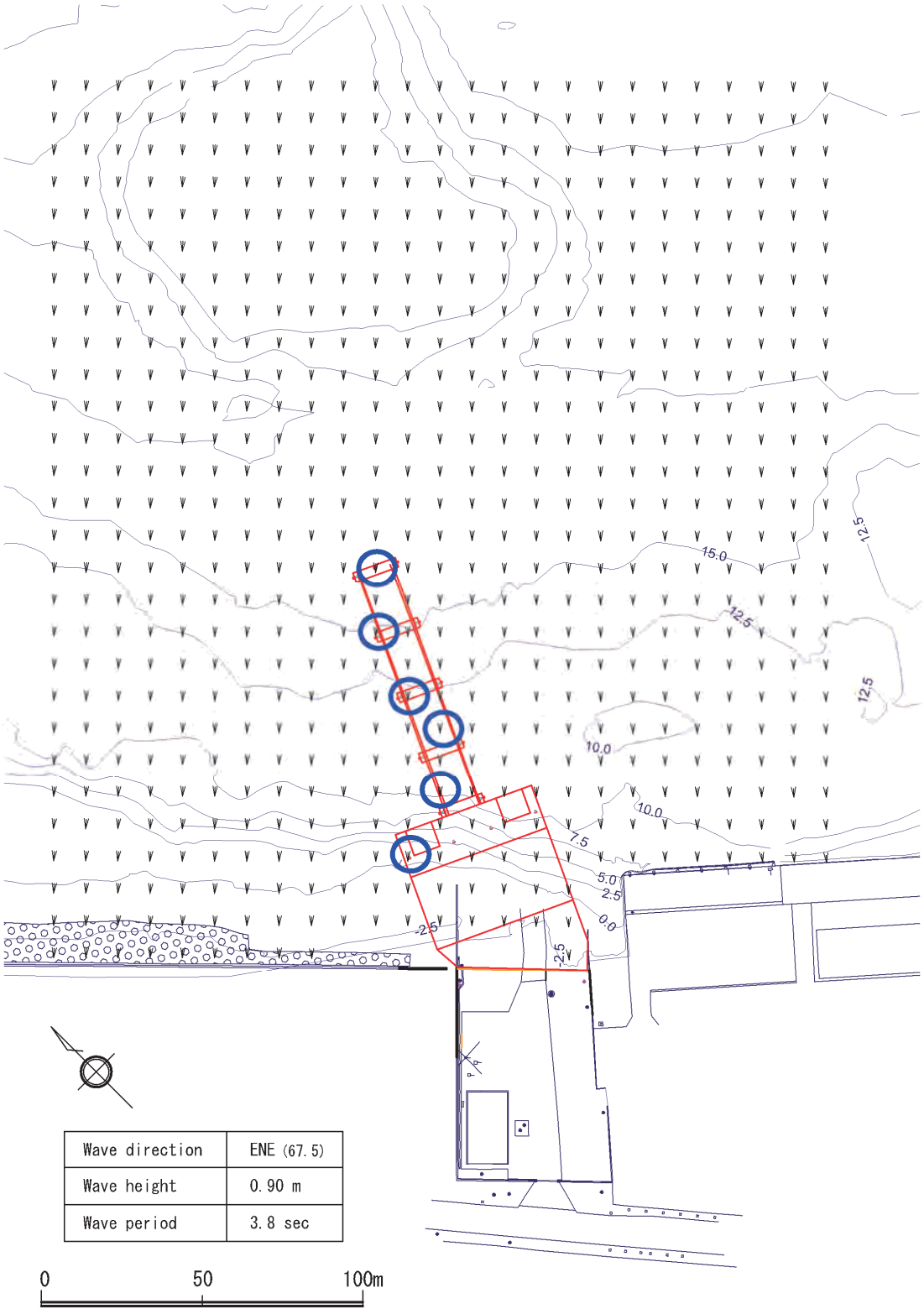


図21　波向ベクトル分布(ENE)

付属資料 6　稼働率計算結果

表１　稼働率計算結果　評価エリアA(利用限界波高　0.3m)

稼働率計算結果

利用限界波高　0.3m　　形 状　　DILI港　　区 域　　評価エリアA

波 向	波高比	沖波波高	利用限界出現率 通年	乾季	雨季		
NW	0.540	0.56	1.962	0.000	3.930		
NNW	0.680	0.44	0.472	0.002	0.943		
N	0.810	0.37	0.167	0.005	0.324		
NNE	0.890	0.34	0.932	1.572	0.288		
NE	0.850	0.35	4.244	6.712	1.760		
		合計	7.776	8.291	7.245		
		稼働率	92.224	91.709	92.755		

乾季：12月～5月
雨季：6月～11月

表２　稼働率計算結果　評価エリアA(利用限界波高　0.5m)

稼働率計算結果

利用限界波高　0.5m　　形 状　　DILI港　　区 域　　評価エリアA

波 向	波高比	沖波波高	利用限界出現率 通年	乾季	雨季		
NW	0.540	0.93	0.162	0.000	0.328		
NNW	0.680	0.74	0.169	0.000	0.348		
N	0.810	0.62	0.091	0.000	0.177		
NNE	0.890	0.56	0.008	0.008	0.000		
NE	0.850	0.59	0.051	0.064	0.032		
		合計	0.481	0.072	0.886		
		稼働率	99.519	99.928	99.114		

乾季：12月～5月
雨季：6月～11月

表 3　稼働率計算結果　評価エリア B(利用限界波高　0.3m)

稼働率計算結果

利用限界波高　0.3m　　形 状　　DILI港　　区 域　　評価エリアB

波 向	波高比	沖波波高	利用限界出現率 通年	乾季	雨季		
NW	0.540	0.56	1.962	0.000	3.930		
NNW	0.680	0.44	0.472	0.002	0.943		
N	0.820	0.37	0.167	0.005	0.324		
NNE	0.900	0.33	0.989	1.669	0.306		
NE	0.860	0.35	4.244	6.712	1.760		
		合計	7.834	8.389	7.263		
		稼働率	92.166	91.611	92.737		

乾季：12月～5月
雨季：6月～11月

表 4　稼働率計算結果　評価エリア B(利用限界波高　0.5m)

稼働率計算結果

利用限界波高　0.5m　　形 状　　DILI港　　区 域　　評価エリアB

波 向	波高比	沖波波高	利用限界出現率 通年	乾季	雨季		
NW	0.540	0.93	0.162	0.000	0.328		
NNW	0.680	0.74	0.169	0.000	0.348		
N	0.820	0.61	0.094	0.000	0.182		
NNE	0.900	0.56	0.008	0.008	0.000		
NE	0.860	0.58	0.054	0.068	0.034		
		合計	0.487	0.076	0.892		
		稼働率	99.513	99.924	99.108		

乾季：12月～5月
雨季：6月～11月