# RESEARCH ON DETERMINING THE TWO - LANE CHANNEL WIDTH FOR VESSELS ON THE HAIPHONG CHANNEL ROUTE THROUGH LACHHUYEN PORT, HAIPHONG, VIETNAM

## NGUYEN XUAN THINH[1*], PHAN TRONG TUE[2]

*[1]Faculty of Civil Engineering, Vietnam Maritime University, Haiphong, Vietnam*
*[2]Vietnam Maritime and Waterway Administration*
*\*Corresponding email: thinhms@vimaru.edu.vn*

## Abstract

*Maritime channel projects leading to national port systems have been continuously invested in and implemented annually by the Vietnam Maritime Administration. Among these, Hai Phong Port is the most modern national seaport in the Northern region, equipped with advanced facilities and comprehensive infrastructure, making it well-suited for multimodal transport and international trade. The functional areas of Hai Phong Port are organized according to their infrastructural and transport advantages—road, rail, and inland waterway—and are equipped with appropriate handling equipment tailored to different cargo types, thereby meeting diverse transport demands.*

*In particular, the Lach Huyen terminal serves as the main port area, primarily handling general cargo and containers, while also functioning as an international transshipment hub. By 2030 and beyond, the terminal is projected to accommodate general cargo vessels of up to 100,000DWT and container ships of up to 8,000TEU, with an annual throughput capacity of approximately 115-125 million tons.*

*Accordingly, this paper presents a study on calculating the two-lane channel width required for the simultaneous operation of 160,000DWT and 5,000DWT vessels along the Hai Phong fairway segment passing through Lach Huyen Port. The aim is to enhance inland access while ensuring the continuity of international cargo flows at Lach Huyen Port, Haiphong City.*

**Keywords**: *Maritime channel, Haiphong Port, Lachhuyen port, Container port, design channel.*

## 1. Introduction

Hai Phong Port is the most modern national seaport in the northern region, equipped with advanced facilities and complete infrastructure, making it suitable for various modes of transportation and international trade. The different areas of Hai Phong Port are organized according to their advantages in infrastructure, road-rail-waterway connectivity, and are equipped with appropriate handling equipment for each type of cargo, thereby meeting and satisfying multimodal transport demands. As of the present time, Hai Phong Port comprises 98 berths with a total length of approximately 14,178.5 meters.

The Lach Huyen channel segment is situated downstream of the Hai Phong maritime fairway, serving all inbound and outbound vessels of Hai Phong Port as well as the Yen Hung-Chanh River terminal area in Quang Ninh Province. On average, the channel accommodates approximately 64 vessel movements per day, peaking at around 80, with up to six vessels transiting simultaneously in convoy during peak hours.

Together with the wide diversity of vessel sizes and categories—including merchant ships, naval vessels, government service ships, passenger vessels, river craft, fishing boats, pilot boats, and supply ships delivering fuel and provisions—the Lach Huyen channel experiences a very high density of maritime traffic, resulting in complex navigational patterns. In addition to the standard fairway routes (Lach Huyen - Ha Nam Channel - Trap Channel - Bach Dang River), there are special or irregular routes, such as voyages to the Nosco Shipyard on the upstream Chanh River, high-speed ferries from Got Ferry to Cat Ba Island, and spontaneous routes of fishing and service vessels. Therefore, research into traffic separation schemes tailored to specific vessel types is necessary to reduce management difficulties and mitigate potential maritime safety risks in this area [4].

Moreover, with the reception of container vessels

up to 100,000DWT (with actual drafts typically ranging from 13m to 14.5m and minimum steerage speed above 8knots), the current conditions of the Lach Huyen channel—maximum width only 160m and depth -14m—pose challenges, especially at low tide. Certain draft-limited container ships may encounter serious difficulties when attempting to meet or overtake within the narrow fairway. This increases maneuvering risks and the possibility of collisions with smaller vessels due to hydrodynamic interaction effects (the "ship suction" phenomenon). With such high traffic density, vessel diversity, and size variation, maintaining a single common fairway for all vessel types, as currently practiced, is no longer appropriate and does not ensure navigational safety [5].

Given the significance of this maritime route within the Northern Seaport Group 1 cluster—particularly the shared Lach Huyen channel segment from buoy P "0" to the branching points of the Bach Dang and Chanh River fairways, where all types of vessels operate, from large ships of up to 100,000DWT to small passenger, fishing, and service vessels—it is imperative to study and implement traffic separation schemes. In other words, establishing differentiated navigational channels for specific vessel classes entering and exiting the area is essential to minimize accident risks and to facilitate effective traffic management and ship maneuvering [6].

## 2. Study on Determining the Number of Navigation Lanes in the Lach Huyen Channel

According to statistical data from the Vietnam Maritime Administration, the forecasted vessel traffic volume in the Lach Huyen channel, Haiphong is presented in the following Table 1.

*Table 1. Forecast table of Vessel Traffic Volume in the Lach Huyen Channel, Haiphong in 2030*

| No | Ship (DWT) | Number of ship | Ratio | Average ship/ day |
|----|------------|----------------|-------|-------------------|
| 1 | < 20.000 | 18222 | 64% | 61 |
| 2 | 20.001 - 30.000 | 7503 | 26% | 25 |
| 3 | 30.001 - 100.000 | 2675 | 9% | 9 |
| 4 | **Total** | **28400** | **100%** | 95 |

Based on the statistical table above, the number of traffic lanes is calculated using the following formula:

$$k = \frac{N_n . \tau}{24 . n . K_{kt}} \qquad (1)$$

In which:

+ $k$: Calculated number of navigation lanes;

+ $N_n$: Average vessel traffic volume over a 24-hour period;

+ $n$: number of vessels in a convoy; here $n=5n=5n=5$ vessels (reflecting current practice);

+ $K_{kt}$: Coefficient accounting for meteorological and hydrological conditions; $Kkt=0.9K\_\{kt\} = 0.9Kkt=0.9$;

+ $24$: number of hours in a day, representing the nominal time available for vessel navigation on the channel.

In 2020, with only two berths in operation, the average number of vessel turnarounds at the Lach Huyen turning basin was about one per day, with an estimated duration of 50 minutes per turnaround. Consequently, the effective navigational time on the channel was 23.17 hours

2030, according to the development plan, the Lach Huyen terminal will comprise approximately nine berths. The average number of vessel turnarounds at the Lach Huyen turning basin is expected to be about three to four per day, with an estimated duration of 50 minutes per turnaround. Consequently, the effective navigational time on the channel will be reduced to approximately 20.7 hours [1].

$\tau$: The transit time for each vessel passage on the channel (in hours) is calculated as follows:

$$\tau = \frac{L}{V_m} + n.t \qquad (2)$$

$L$: Calculated channel length, *km*;

$V_m$: Average vessel speed on the channel; taken as $V_m = 4m/s = 14.4km/h$, equivalent to 8 nautical miles per hour;

$t$: Safe time interval between vessels in a convoy; selected as $t=0.15$ hours, corresponding to a safe distance of 200 meters between vessels;

The calculated results for the design number of navigation lanes are presented in the Table 2.

According to the forecasted average number of vessels passing through the Lach Huyen channel per day, the majority are vessels of less than 30,000DWT, accounting for 86-95% during the 2020-2030 period.

Therefore, the calculated two navigation lanes will primarily be established for vessels up to 30,000DWT (two lanes for ships ≤30,000DWT). Larger vessels may navigate using two lanes in combination, consisting of one large vessel and one smaller vessel (<30,000DWT).

*Table 2. Calculation of the Design Number of Navigation Lanes for the Haiphong Channel, Lach Huyen Section*

| Year | $N_n$ | $L_k$(km) | $V_m$ (km/h) | n |
|------|------|-----------|--------------|---|
| 2020 | 67 | 20,7 | 14,4 | 5 |
| 2030 | 95 | 20,7 | 14,4 | 5 |
| Year | $t_h$ | $T_h$ | k | Chosen Routes |
| 2020 | 0,15 | 2,19 | 1,4 | 2 |
| 2030 | 0,15 | 2,19 | 2,23 | 2 |

*Noted: $N_n$: Average ship/ day; $L_k$(km): Length of channel; $V_m$: Speed of ship; n: Ship/ ships; $t_h$: Safe time; $T_h$: Once time per maneuvering; k: Calculated ship routes.*

## 3. Determination of Parameters for the Widened Navigation Channel

Tables and figures should be placed on the same page as the corresponding explanatory text whenever possible. Each table and figure must include a caption and, if applicable, a source note for the data.

Tables and figures should be numbered sequentially in the order in which they appear in the manuscript.

According to the national standard TCVN 11419:2016: Maritime Channels - Design Requirements

The width of a one-lane channel is determined by the following formula:

$$W = W_{BM} + W_i + W_{BR} + W_{BG} \qquad (3)$$

The width of a two-lane channel is determined by the following formula:

$$W = 2W_{BM} + 2W_i + W_{BR} + W_{BG} + W_p \qquad (4)$$

Where:

$W_{BM}$: Maneuvering strip width, accounting for vessel maneuverability;

$W_i$: Additional width allowance under difficult conditions due to wind, current, or navigational equipment effects;

$W_{BR}$ and $W_{BG}$: Lateral clearance distances on both channel sides;

$W_p$: Separation distance between two vessels.

In the case of a vessel with a deadweight tonnage (DWT) of 30,000, the calculated width of a single-lane channel is 111m, while the width of a two-lane channel is 240m. Thus, based on the above calculation results, it can be observed that according to the forecasted average number of vessels passing through the Lach Huyen channel per day, the majority of ships in the period 2020-2030 are those of less than 30,000 DWT, accounting for 86-95%. Therefore, the two calculated lanes will be designed primarily for vessels up to 30,000DWT (two lanes for ships ≤30,000DWT); larger vessels may navigate using two lanes in combination, with one large vessel and one smaller vessel (<30,000DWT).

Based on the dredged channel bottom elevation of -16.0m and side slope ratio *m =10.15*, it is shown that an additional widening of 80 m on the right-hand side would yield a channel bottom depth ranging from -7.0m to -7.3m, equivalent to the width and depth of the existing Bach Dang channel and Ha Nam canal (-7.0m depth, 80m width). Therefore, to take advantage of the existing slope depth of the Lach Huyen channel, it is recommended to extend the system of navigational buoys 80m to the right side of the channel (the left side is reserved for the planned Lach Huyen terminal system), thereby increasing the total width of the Lach Huyen channel to 240m. This would allow two lanes for vessels up to 30,000DWT as calculated above, or two lanes accommodating one larger vessel plus one smaller vessel, ensuring sufficient capacity for vessel traffic into Hai Phong Port by 2030. Hence, selecting a design calculation for one 160,000DWT vessel and one 5,000DWT vessel is appropriate for the development trend up to 2030 and the long-term vision for the future [2], [5].

### 3.1. Proposed ship operation options following channel expansion

With the trend of developing deep-water ports extending offshore, the calculation of navigation scenarios for ports located further inland still plays a crucial role in the development of waterway transportation. Therefore, for inland ports, the design vessel sizes considered for operation range from 5,000DWT to 10,000DWT, while for deep-water port areas the design vessel size in the future is projected to reach 160,000DWT, as listed in the following Table 3.

Based on the table above, three reasonable traffic-

separation scenarios for the Haiphong fairway are proposed:

*Option 1: Two-lane channel for vessels up to 30,000DWT.*

*Option 2: Two-lane channel accommodating one vessel up to 50,000DWT and one vessel of 20,000DWT.*

*Option 3: Two-lane channel accommodating one vessel up to 160,000DWT and one vessel of 5,000DWT.*

*Table 3. Design vessel parameters*

| No | Design vessel size (DWT) | Vessel length (m) | Vessel beam (m) | Full-load draft (m) |
|---|---|---|---|---|
| 1 | 160.000 | 366 | 51,2 | 14,5 |
| 2 | 100.000 | 330 | 45,5 | 14,8 |
| 3 | 70.000 | 280 | 41,8 | 13,8 |
| 4 | 50.000 | 267 | 32,2 | 12,5 |
| 5 | 30.000 | 210 | 30,0 | 10,7 |
| 6 | 20.000 | 174 | 26,2 | 9,2 |
| 7 | 10.000 | 130 | 21,2 | 7,3 |
| 8 | 5.000 | 105 | 15,8 | 6,4 |

*Table 4. Calculated channel widths for the three proposed options*

| No | Options | Results | | |
|---|---|---|---|---|
| 1 | Ship maneuverability | Good | Average | restricted |
| 2 | Option 1 | | | |
| 3 | Two-lane operation for 30,000 DWT vessel | 240 | 252 | 270 |
| 4 | Option 2 | | | |
| 5 | Two-lane operation: 50,000 DWT vessel + 20,000 DWT vessel | 234 | 245 | 263 |
| 6 | Option 3 | | | |
| 7 | Two-lane operation: 160,000 DWT vessel + 5,000 DWT vessel | 214 | 228 | 248 |

As a result; the calculation results show that a channel width of B = 240m is adequate for two-lane navigation, accommodating either two vessels of 30,000DWT, or one vessel of 160,000DWT together with one vessel of 5,000DWT, or one vessel of 50,000DWT together with one vessel of 20,000DWT. This configuration is considered appropriate, as smaller vessels of up to 50,000DWT at full load can additionally utilize the left-side channel slope without requiring buoy relocation, thereby enabling safe navigation under average ship maneuverability conditions

### 3.2. Plan operation view of traffic separation in the Lach Huyen section of the Haiphong channel

Based on the existing alignment of the Lach Huyen channel with a width of 160m and a depth of -14.0m, the channel is expanded by an additional 80m to the right side, making use of the existing channel slope. The extended section of 80m has bottom elevations ranging from -7.0m to -7.3m, thereby increasing the total channel width to 240m, forming a two-lane channel capable of accommodating either two vessels of 30,000DWT, or one vessel of 160,000DWT together with one vessel of 5,000DWT, or one vessel of 50,000DWT together with one vessel of 20,000DWT.



*Figure 1. the Lach Huyen section of the Haiphong channel*

In the two-lane configuration, the extended 80m section intersects at the turning basin area near Berths 1 and 2 of Lach Huyen Port, where the water area is sufficiently wide and has already been dredged to a depth of -14.0m. The existing buoyage system on the right side of the channel will be shifted outward to control the new channel width of 240m. For the

reception of large vessels up to 100,000 DWT - 160,000DWT, a width of 160m will be utilized in combination with a virtual AIS system to guide vessels entering and leaving the channel.
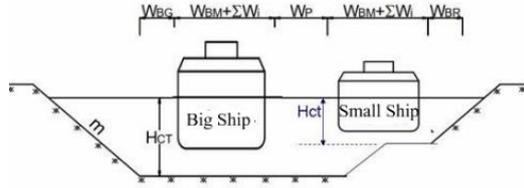


*Figure 2. the typical ship cross section*

## 4. In conclusions

The study proposed a method for analyzing and evaluating the current conditions and development of both the Vietnamese and international fleets during the operation of the Haiphong seaport system. It presented analytical results on vessel traffic volume and provided the basis for assessing channel depth and width in order to establish appropriate design solutions for different ship sizes and load conditions.

The study has provided calculated results of channel parameters for different two-lane traffic separation schemes, including the case of two vessels of 30,000DWT, the case of one vessel of 50,000DWT together with one vessel of 20,000DWT, and the case of one vessel of 160,000DWT together with one vessel of 5,000DWT simultaneously operating on the Haiphong channel, specifically the Lach Huyen section of the Hai Phong port area. These findings are consistent with the port's development vision toward 2030 and in the future.

## REFERENCES

[1] National Technical Regulation on Maritime Signaling Systems, QCVN 20:2010/BGTVT, issued together with Circular No. 17/2010/TT-BGTVT dated July 5, 2010, by the Minister of Transport.

[2] Decision on Approval of the Detailed Master Plan for the Northern Seaport Group (Group 1) to 2020, with Orientation to 2030, Decision No. 1741/QD-BGTVT dated August 3, 2011, by the Minister of Transport.

[3] Hai Phong Maritime Administration, Official Website: www.cangvuhaiphong.com.vn.

[4] Ministry of Transport of Vietnam, Official Website: www.mt.gov.vn.

[5] Vietnam Maritime Administration (VINAMARINE), Official Website: www.vinamarine.gov.vn.

[6] Northern Vietnam Maritime Safety Corporation (VMS-North), Official Website: www.vms-north-vn.