# The research of reasonable coastline length on fish pier based on Arena software

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**Abstract:** In this article, fish piers are divided into two categories, piers for unloading fish and providing ice. First of all, the number of berths and pier length are obtained on the condition of discharging quantity of products in the dock, in different years, according to the original standard formulas. Then, the operation process of fishing boats in the ports is simulated on the method of Arena software. The reasonable coastline length corresponding to discharging quantity of products in the dock, in different years, is obtained. Last, the simulation results are compared with the theoretical results. The reasonable coastline length of piers for unloading fish and providing ice are obtained, corresponding to discharging quantity of products in the dock in different years.

## The calculation on fishing pier norm

The aim of fish pier plan is to obtain the biggest comprehensive benefit of both the fishing ports and fishing boats. The use of pier coastline is the most reasonable.

In the previous norms[1], fish piers are divided into unloading fishing berth, providing ice, providing supplies and oil pier and so on, according to the application. After investigation, both secondary and tertiary fish piers are not set piers for supplies. These supplies are offered in piers for unloading fish and providing ice in order to simplify the process and avoid the confusion phenomenon that is caused by the repeating transfer of fishing boats in the harbor. On the premise of fire protection, if the position of oil depot is appropriate, oil tubes are equipped in the dock for ice, generally. The oil of fishing boats is offered in the dock for ice, without a single oil dock. While, the oil dock is set when the oil reservoir area is far away from the port or laying pipes is not economic. If the oil of fish pier is transported by waterway, a dock for unloading oil should is established.

In the paper, fish piers are divided into the unloading fishing berth and providing ice. These supplies and oil are offered in the providing ice berth. The coastline length of the unloading fishing berth depend on discharging quantity of aquatic product in the dock per year, including the discharging quantity of fishing and aquaculture aquatic product. The coastline length of the providing ice berth also depends on discharging quantity of aquatic product.

The calculation method on the number of berth for unloading fish and the providing ice berth is offered in the previous norm, as follows.

The formula on the number of berth for unloading fish corresponding to the annual throughput on the dock:

$$N_1 = \frac{Q}{ZC_1K_1}(1)C_1 = t_1P_1(2)N_1$$——the number of berth for unloading fish;

Q——discharging quantity of aquatic product in the dock, t;

Z——the annual average work days, d. The calendar days subtract the sum days of bad weather, pier maintenance and fishing ban. The days of bad weather and pier maintenance depend on the actual situation of the dock. If the measured data is not obtained, the number is 40~60d. In the paper, the number is 90d;

$C_1$——the unloading fish ability of berth, t/d;

$K_1$——berth occupancy rate of the unloading fishing berth, the ratio of the annual average operation time of ships on the dock and the annual average operation time;

$t_1$——the effective unloading fish time per day, h, 13h;

$P_1$——the effective unloading fish ability of berth, t/h. If measured data is not offered, the ability of marine crane is 5~9t/h, In the paper, the number is 7t/h.

The formula on the number of berth for providing ice corresponding to the annual throughput on the dock:

$$N_2 = \frac{QW}{ZC_2K_2} \qquad (3)$$

$$C_2 = t_2P_2 (4)$$

$N_2$——the number of berth for providing ice;

W——needed ice quantity of aquatic products per ton (1.0~1.3t/t). In the paper, all kinds of fishing boats take 1.0;

$C_2$——the ability of adding ice on berth per day, t/d;

$K_2$——berth occupancy rate of the providing ice berth, (0.46~0.6) , take 0.5;

$t_2$——the effective adding ice time per day, h（8~5h）, take 6h;

$P_2$——the effective crushed ice ability of ice crusher, t/h. If measured data is not offered, the ability is 20~40t/h. In the paper, the number is 30t/h.

The fishing boats are divided into small fishing boats (berth length is 17m), medium-sized fishing boats (berth length is 38m) and large fishing boats (berth length is 52m), according to the size of the boat length. The ratio of different size fishing boats reached the port:

Small fishing boats: Medium-sized fishing boats: Large fishing boats = 0.3:0.4:0.3 (the annual throughput on the dock is 10~60 thousand ton);

Small fishing boats: Medium-sized fishing boats: Large fishing boats = 0.3:0.35:0.35（the annual throughput on the dock is 70~150 thousand ton）;

Small fishing boats: Medium-sized fishing boats: Large fishing boats = 0.25:0.4:0.35（the annual throughput on the dock is 160~200 thousand ton）.

The berth length is taken as 38m on the weighted average method (the weighted average results of small, medium-sized and large design standard fishing boats is 35.59m, 36.6 m and 37.65m, separately. While the berth length of medium-sized fishing boats is 38 m. The representative berth length for fishing boats takes the berth length for medium-sized fishing boats). The dock coastline length for unloading fish and providing ice corresponding to the annual throughput on the dock is calculated on the method of previous norm (calculation form as shown in table 4).

**The simulation results on the method of Arena software**

Arena is a kind of management system simulation software[2]. It has the practicability of high-level simulation and the flexibility of simulation language. The basis of modeling tools is module in Arena. The simulation model is established by connecting the modules. Hierarchical modeling system is used in Arena to ensure the flexibility of simulation modeling at all levels. Modeling levels increase in turn with modeling hierarchy from the bottom to up. Different levels of modeling method are used interchangeably under the visual simulation environment of Arena to obtain

different modeling capabilities[3]. The operation process of fishing boat reached the port is based on Arena software. The docks are divided into the dock for unloading fish and the dock for providing ice. The supplies and oil are offered on the dock for providing ice. The operation process is shown in following figure[4].
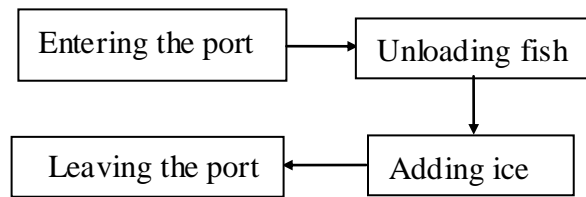


The time interval of fishing boats reached port are shown in the following table 1. Table 2 shows the weight of fish loaded[5].

Tab.1 the time interval of fishing boats reached port corresponding to discharging quantity of product per year on the dock

| Annual throughput in the fishing port(10thousand t) | The time interval of fishing boats reached port(h) | Annual throughput in the fishing port(10thousand t) | The time interval of fishing boats reached port(h) | Annual throughput in the fishing port(10thousand t) | The time interval of fishing boats reached port(h) |
|---|---|---|---|---|---|
| 1 | 4.07 | 8 | 0.505 | 15 | 0.27 |
| 2 | 2.04 | 9 | 0.45 | 16 | 0.26 |
| 3 | 1.4 | 10 | 0.4 | 17 | 0.24 |
| 4 | 1.01 | 11 | 0.37 | 18 | 0.23 |
| 5 | 0.82 | 12 | 0.34 | 19 | 0.21 |
| 6 | 0.68 | 13 | 0.31 | 20 | 0.2 |
| 7 | 0.59 | 14 | 0.29 | | |

Tab.2 the maximum weight of fish loaded in various fishing boats

| Small fishing boat | | Medium-size fishing boat | | Large fishing boat | |
|---|---|---|---|---|---|
| Deadweight [t/ship] | Membership | Deadweight [t/ship] | Membership | Deadweight [t/ship] | Membership |
| 2 | 0.3 | 4.5 | 0.3 | 7.5 | 0.3 |
| 3 | 0.45 | 6 | 0.45 | 8.5 | 0.4 |
| 4.5 | 0.25 | 8 | 0.25 | 10 | 0.3 |
| Weight average [t/ship] | 3.45 | Weight average [t/ship] | 6.05 | Weight average [t/ship] | 8.65 |

The data in the following table depend on previous norm and literatures[3,4].

Tab.3 specific statistics data of fishing boat

| | Berth length | the time of entering or leaving port | the time of unloading fish | the time of adding ice and supplies | cost ratio of unloading fish ($C_S/C_b$) | cost ratio of adding ice ($C_S/C_b$) | ratio of adding ice |
|---|---|---|---|---|---|---|---|
| | (m) | （h） | （h） | （h） | | | （t/t） |
| small fishing boat | 17 | 0.5 | 1.1 | 0.5 | 2.3 | 2.8 | 1 |
| medium-sized fishing boat | 38 | 0.8 | 1.6 | 0.6 | 2.9 | 3.4 | 1 |
| large fishing boat | 52 | 1 | 2.1 | 0.7 | 4.1 | 4 | 1 |

The two main control variables of models are the length of the dock for unloading fish and the length of the dock for providing ice[6]. On the condition that discharging quantity of product per year on the dock and the dock coastline length for unloading fish is constant, the lowest comprehensive comprehensive cost is obtained within the scope of the different dock coastline length for providing ice. In the same way, the dock coastline length for unloading fish corresponding to the lowest comprehensive comprehensive cost is got. It is obtained that reasonable dock coastline length for unloading fish and providing ice corresponding to specific discharging quantity of product per year on the dock. Because discharging quantity of product per year on different fish docks have a large gap, 20 kinds discharging quantities of product per year on the dock (discharging quantity of product per year on different fish docks is 10~200 thousand ton. ) is taken to get coastline length corresponding to lowest comprehensive comprehensive cost under each discharging quantities of product per year on the dock. The dock coastline length is the dock coastline length for unloading fish and providing ice corresponding to the sum of the ship cost and port cost.

Discharging quantity of product per year on different fish docks is 100 thousand ton, for example. Table 3 shows the comprehensive cost corresponding to different coastline lengths.

Tab.4 the comprehensive cost corresponding to different dock coastline length

| | 170 | 190 | 210 | 230 | 250 | 270 | 290 |
|---|---|---|---|---|---|---|---|
| 440 | 0.0819 | 0.0827 | 0.0814 | 0.0785 | 0.0787 | 0.0788 | 0.0789 |
| 460 | 0.0822 | 0.083 | 0.0817 | 0.0788 | 0.079 | 0.0791 | 0.0792 |
| 480 | 0.082 | 0.0828 | 0.0815 | 0.0786 | 0.0788 | 0.0789 | 0.079 |
| 500 | 0.0821 | 0.0829 | 0.0816 | 0.0787 | 0.0789 | 0.079 | 0.0791 |
| 520 | 0.0824 | 0.0832 | 0.0819 | 0.079 | 0.0792 | 0.0793 | 0.0794 |
| 540 | 0.0824 | 0.0832 | 0.0819 | 0.079 | 0.0792 | 0.0793 | 0.0794 |
| 560 | 0.0824 | 0.0832 | 0.0819 | 0.079 | 0.0792 | 0.0793 | 0.0794 |
| 580 | 0.0801 | 0.0809 | 0.0796 | 0.0767 | 0.0769 | 0.077 | 0.0771 |
| 600 | 0.08 | 0.0811 | 0.0798 | 0.0769 | 0.0771 | 0.0772 | 0.0773 |

(Indicata:The first row means the ice quay length,the first column means the unload fishing quay length,untis are m.)
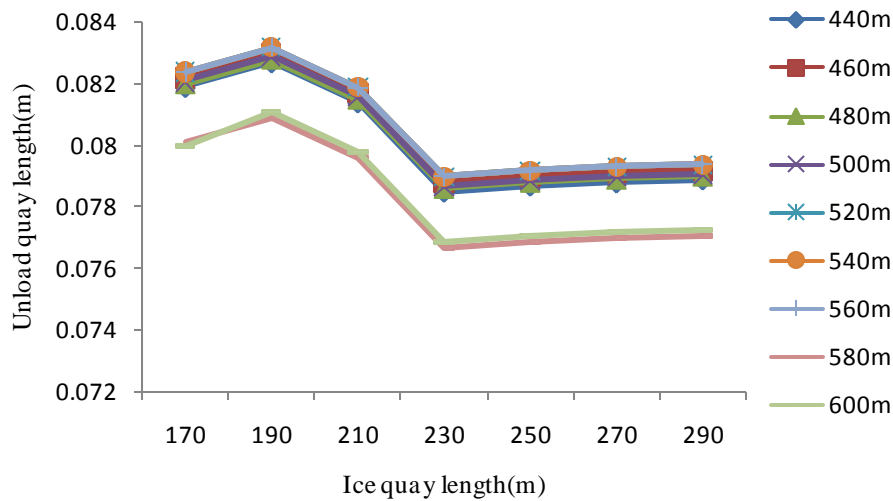
Fig.1 the line chart on the comprehensive cost corresponding to different dock coastline length

As shown in figure 1, when the coastline length for providing ice is constant, the comprehensive comprehensive costs reduce after increasing with the increase of the coastline length for unloading fish. In the end the trend of increase appears. When discharging quantity of product on the dock is 100,000 t, the coastline length for unloading fish is 580m. When the coastline length for providing ice is 230m, the lowest comprehensive comprehensive cost is 0.0767/t[7]. Table 4 shows the lowest comprehensive comprehensive cost and the dock coastline length corresponding to discharging quantity of product on the dock.

Tab.5 The sum dock coastline length corresponding to discharging quantity of product per year on the dock

| The annual throughput port(10 thousand t) | Simulation quay length(m) | Normed quay length(m) | The annual throughput port(10 thousand t) | Simulation quay length(m) | Normed quay length(m) |
|---|---|---|---|---|---|
| 1 | 200 | 190 | 11 | 840 | 798 |
| 2 | 240 | 154 | 12 | 835 | 798 |
| 3 | 330 | 304 | 13 | 825 | 798 |
| 4 | 430 | 380 | 14 | 845 | 798 |
| 5 | 470 | 456 | 15 | 850 | 798 |
| 6 | 530 | 532 | 16 | 870 | 874 |
| 7 | 530 | 532 | 17 | 870 | 874 |
| 8 | 700 | 646 | 18 | 880 | 874 |
| 9 | 730 | 684 | 19 | 885 | 874 |
| 10 | 810 | 798 | 20 | 885 | 874 |

Table 5 shows that the simulation results and norm results on the number of berth and dock coastline length for unloading are consistent. So do the dock for providing ice. The conclusion ensures the accuracy of the simulation results. When discharging quantity of product on the fish dock reaches a certain value, the coastline length of the dock for unloading fish and providing ice has increase trend. The trend slows down and almost remains the same. The phenomenon indicates that the utilization rate of fish dock coastline increases and comprehensive comprehensive cost reduces, with the increase of discharging quantity of product on the fish dock[8].

The above table shows that the dock coastline total length reduce and the utilization rate of dock coastline increases, when discharging quantity of product on the dock is less than 70 thousand ton.

But the waiting time of ship increases and the comprehensive comprehensive cost increases. The dock coastline total length is larger when discharging quantity of product on the dock is more than 80 thousand ton (including 80 thousand ton). Among them the dock for unloading fish represents a significant share.

## Conclusion

The model on the operation process of fish boat reached port is built though Arena simulation software. The simulation results close to the results from previous norm. The compare between the two results indicates the accuracy of simulation results. The discharging quantity of product on fish dock is one of important indicators on the plan of coastline length of fish port. The above results indicate coastline length of fish dock appears increase trend with the increase of discharging quantity of product on fish dock. But the trend slows down and appears approximate parallels, when discharging quantity of product on fish dock reaches a certain value.

## Reerences

[1]Chinese Ministry of Agriculture Fisheries Bureau,The overall design specification of fishery,SC/T9010-2000.

[2]David Kelton,W.,Randall P(2007).Sadowski,David T. Sturrock, Simulation:theues of software Arena[M], *Machine Press*, Beijing,China.

[3]Pidgeon E D(2008). Modeling the effects of a transportation security incident upon the marine transportation system[D]. Monterey, California. Naval Postgraduate School.

[4]LV Wei.Research on coastline layout with flexible berthing method in container terminal[D].Dalian:Dalian University of Technology,2009(1).

[5]GUI Jin-song.The research on the distribution regularity of fishing vessels arrived randomly in harbor[J].Journal of Dalian Fisherles University,1999,14(3):67-71.

[6]GUI Jin-song.The Determination of the Ratio of the $C_s$ and the $C_b$ by Fishing Ship[J].Port&Waterway Engineering,1999(7):47-51.

[7]GUI Jin-song,ZHOU Mao-yuan.Using Queuing Theory to Calculate the Optimal Utility Factor of Fish Landing[J].Journal of Dalian University,1999,20(6):49-52.

[8]YANG Chun-xia,WANGNuo.Reasonable shoreline utilization rate with flexible berthing in container terminal[J].Port&Waterway Engineering,2010(5):93-97.

[9]Daganzo,C.F.(1989).The crane scheduling problem[J].*Transporation Research-B*, 23(3):159-175.

[10]Merkuryev,Yuri,etal(2000).Arena-based simulation of logistics proceses at the Baltic Container Terminal.*Proceedings of the 2000 European Simulation Multiconference*.May 23-26,Ghent,Belgium,SCS,P.433-437.