Analysis and Research on Standard System and Technical Requirements of Jib Crane

Wei Zhao, Weiting Ning *
China Waterborne Transport Research Institute, Beijing, China

*Corresponding author e-mail: ningwt@wti.ac.cn

Abstract. Jib crane is one of the most important crane types. It has been widely used in lifting heavy load in ports, shipbuilding, hydropower construction, nuclear power construction, equipment manufacturing, railway, construction and metallurgy industries and so on. China is a leading manufacturer, user and exporter of jib crane, therefore this research will compare, analyze and study the standard system and technical requirements of jib crane between China, other countries or regions as well as international field.

1. Introduction
Jib crane refers to the crane whose handling device is suspended on the jib or trolley running along the jib, excluding mobile crane, tower crane, railway crane, floating crane and offshore crane.

There are many kinds of jib cranes, including portal slewing crane, semi-portal slewing crane, pedestal crane, high mast type crane, fixed-base crane, derrick crane, cantilever crane and so on.

In addition, it needs to be clear that the relationship between port machinery and jib crane. Port machinery includes five categories, including port lifting machinery, port handling machinery, port conveying machinery, port continuous handling machinery and other port machinery. The relationship between jib crane, port machinery and lifting appliances is shown in Fig. 1. It can be seen from the figure that jib crane is not only an important part of lifting appliances, but also an important part of port machinery.

![Figure 1. The relationship between jib crane, port machinery and lifting appliances.](image-url)
2. Analysis and research on jib crane standard system

2.1. Jib crane standard system of China

In China, standards include a variety of levels, including national standards, industry standards, local standards, group standards and enterprise standards. Jib crane standard system of China contains 41 items in total. It covers national standards, transportation industry standards, machinery industry standards, standard plans and standards to be formulated in the field of jib cranes. The number of standards at all levels is shown in Table 1.

| Level                        | Published | Plan or to be formulated | Quantity |
|------------------------------|-----------|--------------------------|----------|
| National standard            | 19        | 11                       | 30       |
| Transportation industry standard | 3        | 7                        | 10       |
| Machinery industry standard  | 1         | 0                        | 1        |

The architecture is divided into five parts, including basic standards, service standards, technical standards, product standards and related standards. Each category is subdivided into several subitems, as shown in Fig. 2. The standard quantity of each item is shown in Table 2.

![Figure 2. The architecture of jib crane standard system of China.](image)

| Classification          | Secondary classification                                      | Quantity |
|-------------------------|--------------------------------------------------------------|----------|
| 100 Basic standards     | 101 Vocabulary, classification, definition                   | 4        |
|                         | 102 General standards                                        | 19       |
| 200 Service standards   | 201 Management and service                                   | 0        |
|                         | 301 Detection                                                | 1        |
| 300 Technical standards | 302 Test, acceptance check                                   | 0        |
|                         | 303 Inspection and maintenance                               | 6        |
|                         | 304 Safety, hygiene, environmental protection and energy saving | 5        |
| 400 Product standards   | 401 Technical Requirements of product                        | 6        |

2.2. ISO standard system of jib crane

ISO standard system of jib crane contains 12 standards, and all of standards are current standards, as shown in Table 3.
Table 3. ISO standard system of jib crane.

| Standard number | Standard title                                                                 |
|-----------------|-----------------------------------------------------------------------------|
| ISO 4301-4:1989 | Cranes and related equipment — Classification — Part 4: Jib cranes          |
| ISO 4306-4:2020 | Cranes — Vocabulary — Part 4: Jib cranes                                    |
| ISO 7752-4:1989 | Cranes — Controls — Layout and characteristics — Part 4: Jib cranes         |
| ISO 8566-4:1998 | Cranes — Cabins — Part 4: Jib cranes                                        |
| ISO 8686-4:2005 | Cranes — Design principles for loads and load combinations — Part 4: Jib cranes |
| ISO 9374-4:1989 | Cranes — Information to be provided — Part 4: Jib cranes                   |
| ISO 10245-4:2004| Cranes — Limiting and indicating devices — Part 4: Jib cranes               |
| ISO 10972-4:2007| Cranes — Requirements for mechanisms — Part 4: Jib cranes                   |
| ISO 11660-4:2012| Cranes — Access, guards and restraints — Part 4: Jib cranes                 |
| ISO 12210-4:1998| Cranes — Anchoring devices for in-service and out-of-service conditions — Part 4: Jib cranes |
| ISO 12480-4:2007| Cranes — Safe use — Part 4: Jib cranes                                      |
| ISO 12488-4:2004| Cranes — Tolerances for wheels and travel and traversing tracks — Part 4: Jib cranes |

The architecture of ISO standard system of jib crane is mainly divided into basic standards, parts standards, method standards, safety standards and management standards, as shown in Fig. 3. The number of standards included in each category is shown in Table 4.

![Diagram showing the architecture of ISO standard system of jib crane]

Figure 3. The architecture of ISO standard system of jib crane.

Table 4. Quantity of various standards in ISO standard system of jib crane.

| Classification     | Quantity |
|--------------------|----------|
| Basic standards    | 2        |
| Parts standards    | 6        |
| Method standards   | 1        |
| Safety standards   | 2        |
| Management standards| 1       |

2.3. Contrastive analysis of jib crane standard system

Firstly, analyzing the relationship between them, 11 standards (excluding ISO 4306-4:2020) in ISO standard system of jib crane have been transformed into national standards by China. The new standard which be added to ISO standard system in 2020——ISO 4306-4:2020, was proposed by China and leading compiled by Chinese experts on the basis of Chinese national standard.

Secondly, comparing the establishment principle, although jib crane standard system of China is established based on adopting and transforming ISO standards, there are many differences between the two standard systems in framework establishment and standard development. ISO standard system puts more emphasis on parts standards, with the largest number of standards and the largest proportion. Besides, ISO standard system of jib crane is short of standards for test methods. Most jib crane standards of China are established according to crane type. Each type generally includes three standards: technical requirements, safety rules and repairing technique rules.

Thirdly, the framework of jib crane standard system of China is clearer and its classification is more exhaustive. Users can clearly and accurately gain the required standard information.
3. Analysis and research on jib crane technical requirements

By comparing the contents and technical requirements of jib crane standards of China, ISO standards and European standards, the following differences can be found.

3.1. Framework of standard technical requirements

Chinese standards put emphasis on the requirements of parts and mechanisms, accounting for the largest number of standards and the most detailed requirements. This part accounts for the largest proportion, and is required in detail. From metal structure to weld, from wheel, wire rope, brake to hydraulic system, as well as lifting, luffing, slewing and travelling mechanism, all of items are specified in sequence. Then the requirements of electrical and safety protection devices are put forward. ISO standards and European standards put emphasis on human-mechanism security and safety protection, and put the requirements of electrical equipment in front position of standard. Hazard list is listed in front of the technical content to inform the users of the standards that the possible hazards when using the crane and its position of relevant requirements in this standard. In the technical content, the strength and stability requirements are first specified, followed by electrical equipment requirements, and then non electrical equipment requirements.

Moreover Chinese standards focus on the whole process from design to use, the requirements of each work process are mentioned in standard. However, some requirements are not usually mentioned in ISO standards and European standards, such as working conditions, assembly and installation requirements, acceptance, packaging, transportation and storage.

3.2. Main technical differences

Through comparison, analysis and research, the main difference in technical contents of the standard is the coefficient of static load test and dynamic load test.

According to the Chinese national standard, the load of static load test needs to bear 1.25 times of the rated load, and the load of dynamic load test needs to bear 1.1 times of the rated load. According to EN standards, the load of static load test needs to bear 1.5~1.2 times of the rated load (Table 5), and the load of dynamic load test needs to bear 1.1 times of the rated load. According to FEM standards, the load of static load test needs to bear 1.4 times of the rated load, and the load of dynamic load test needs to bear 1.2 times of the rated load.

Through comparison and analysis, it can be seen that the European standard has more stringent requirements for the structural strength and working characteristics of the jib crane.

Table 5. Coefficient of static load test in EN standard.

| Mass of rated capacity (m<sub>RC</sub>) | Coefficient of static load test |
|--------------------------------------|---------------------------------|
| m<sub>RC</sub>≤20 t                  | 1.50                            |
| 20 t<m<sub>RC</sub>≤120 t            | 1.56~0.003 m<sub>RC</sub>[t]     |
| 120 t<m<sub>RC</sub>                 | 1.20                            |

4. Conclusion

In view of the frequent accidents of jib cranes in recent years, it is very important to supplement and improve the safety protection standards, and enhance implementation of the current standards. With the change of user demand and the continuous progress of technology, the development of large-scale and intelligent of jib crane is obvious. In order to promote the development of jib crane industry, it is significant to strengthen international communication and cooperation of jib crane standards.

Acknowledgments

This work was financially supported by WTI research fund.
References
[1] Dexin Tao, Yunfu Yan, Dashan Dong, Dewen Zhang, Handbook of construction machinery•Port machinery, first ed., Tsinghua university press, Beijing, 2017.
[2] Chunhui Zhao, The Domestic Expert Working Group Meeting for the ISO 4306-4 Cranes-Terminology-Part 4: Jib Cranes, J. Lifting the transport machinery. 5(2020) 31.
[3] Information on http://www.iso.org