Asahi-Shuzo Sake Brewing:
New Shorai Brewery and New Storehouse

― 朝日酒造新松籟蔵・新貯蔵棟 ―

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Synopsis

Asahi-Shuzo Sake Brewing Co., Ltd. is known for sake brands such as Kubota. Over roughly 26 years, the same owner, designer, and contractor built 10 buildings on the company's site as a long-term project. The main structure of these buildings is made of steel-reinforced concrete (SRC) and the main finishing on their external walls is fair-faced concrete.
To prevent and control cracking of the fair-faced concrete on the external walls, the latest projects, namely the New Shorai Brewery (**Fig.1**) and the New Storehouse (**Fig.2**), introduced technologies such as expansive concrete and optimum joint spacing based on predicting shrinkage cracking. Moreover, these applied technologies were verified on the actual buildings. As a result, there was almost no cracking four years after completion.

Fig.1 New Shorai Brewery

Fig.2 New Storehouse

Structural Data

(1) New Shorai Brewery

Structure: SRC and Steel Mixed, 5F and PH 1F
Site area: 42,863m^2
Building area: 3,059m^2
Total floor area: 11,783m^2
Maximum height: 30.60m
Owner: Asahi-Shuzo Sake Brewing Co., Ltd.
Designer: Choken Sekkei
Contractor: Shimizu Corporation
Construction period: June 2009 – June 2011
Location: 880-1 Asahi, Nagaoka-city, Niigata-prf, Japan

Fig.3 View of Asahi-Shuzo Sake Brewing site

(2) New Storehouse

Structure: SRC and Steel Mixed, 3F
Site area: 42,863m^2
Building area: 1,023m^2
Total floor area: 2,668m^2
Maximum height: 28.55m
Owner: Asahi-Shuzo Sake Brewing Co., Ltd.
Designer: Choken Sekkei
Contractor: Shimizu Corporation
Construction period: Oct. 2011 – Dec. 2012
Location: 880-1 Asahi, Nagaoka-city, Niigata-prf, Japan

1. Introduction

Asahi-Shuzo Sake Brewing Co., Ltd., known for sake brands such as Kubota[1], Asahiyama, and Esshu, was established in 1830. It is located in Nagaoka-city, Niigata Prefecture, an area that experiences heavy snowfall.

Over roughly 26 years as a long-term project[2], the same owner, designer, and contractor built 10 buildings on site, including breweries and storehouses (**Fig.3**). The main structure of these buildings is made of SRC, and the main finishing on their external walls is fair-faced concrete. These create beautiful scenery with a sense of unity as a whole. Furthermore, they form landscapes that fuse with the natural environment such as the surrounding rice fields and uncultivated woodland.

To prevent and control cracking of the fair-faced concrete on the external walls, the latest projects, namely the New Shorai Brewery (**Fig.4**) and the New Storehouse (**Fig.5**), introduced technologies such as concrete with an expansive additive and optimum joint spacing by predicting shrinkage cracking. These applied technologies were verified on the actual buildings. In addition, they were constructed carefully based on abundant experience. As a result, there was almost no cracking of these buildings four years after they were completed. The projects are summarized herein.

2. Design

(1) Concept

Coming from a rich natural environment, the rice and water used to brew sake has an enormous influence on its fragrance and taste. Asahi-Shuzo Sake Brewing has always brewed its sake amid natural beauty in an area surrounded by rice fields and uncultivated woodland. The concept is “a village with a sake brewery”.

(2) Architectural Design

Fair-faced concrete finishing was adopted for the external walls, and the design was kept deliberately simple to blend the buildings into the surrounding landscape. Additionally, no fence separates the site from its surroundings for a connected vision [3].

(3) Structural Design

An aseismic structure involving SRC beams to a column frame and reinforced concrete (RC) walls

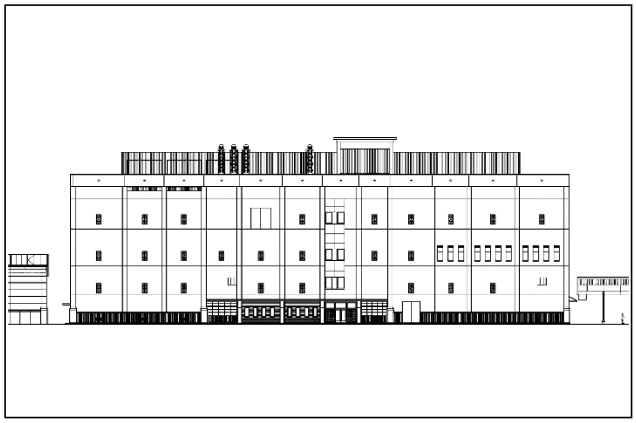

Fig.4 North elevation of New Shorai Brewery

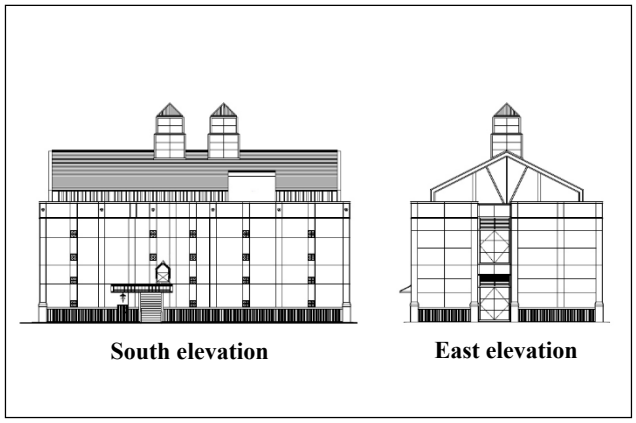

Fig.5 South and east elevation of New Storehouse

Fig.6 Inspection of surface concrete quality

Fig.7 Construction in heavy snowfall

was adopted because some buildings have survived powerful earthquakes such as the Mid Niigata Prefecture Earthquake in 2004 and the Niigata-ken Chuetsu-oki Earthquake in 2007 for 26 years.

3. Construction

(1) Concrete with Expansive Additive

The design strength of the concrete with an expansive additive (ettringite and lime complex) was 30N/mm^2. The drying shrinkage rate of concrete was 645×10^{-6}. Moreover, it was equal to 545×10^{-6} by the effect of expansive additive, and the concrete specification was a special grade in Japan[4]. Furthermore, the quality control of expansive concrete[5] was carried out to standard JCI-S-009-2012.

(2) Concrete Casting and Curing

Concrete casting and curing were carried out faithfully to the basic plan. Less than 130m^3 of concrete was cast per day. Especially on the external walls, working more carefully for compaction, less than 15m^3 of concrete was cast per hour. The concrete was cured over seven days, 14 days for the 1F external wall. Furthermore, inspection tests for air permeability and surface water absorption were undertaken to evaluate the construction quality (**Fig.6**); the results showed the material to have high denseness and low permeability. Thus, these buildings are highly durable [6] [7].

(3) Measures against Heavy Snowfall

In winter, the average cumulative snowfall on Nagaoka-city exceeds 300cm. Therefore, concrete construction did not take place in winter; the exception was the New Storehouse construction, whose movable temporary roof that considered snow accumulation allowed concrete construction to proceed (**Fig.7**). Also, heat curing to prevent the initial frost damage of concrete was optimized by three-dimensional finite-element temperature stress analysis.

4. Cracking Prevention and Control

To enhance creativity and to prevent and control shrinkage cracking, the joint spacing on external walls was optimized by predicting shrinkage cracking using a method known as the modified Base and Murray method[4]. An example of a calculation by this method is given in **Table-1**. The number of inducing joints changes depending on the restraint rate of wall members. However, the restraint rate of the SRC structure is unknown in general. Therefore, to check the restraint rate, the actual strain of the slab and external wall were measured by a strain gauge and thermocouple during construction of the New Shorai Brewery. The joint spacing of the external wall on the upper floor was also optimized on the basis of the results for the lower floor. Furthermore, the effect on the actual structure of cracking reduction due to the expansive additive was evaluated from the measurement results[8] (**Fig.8**).

5. Conclusion

To prevent and control cracking of the fair-faced concrete on the external walls, the latest projects, namely the New Shorai Brewery and the New Storehouse, introduced the technologies such as the concrete with expansive additive and optimum joint spacing by predicting shrinkage cracking. These applied technologies were verified on the actual buildings. In addition, they were constructed carefully based on abundant experience. As a result, there was almost no cracking on these buildings four years after they were completed.

The Asahi-Shuzo Sake Brewing New Shorai Brewery and New Storehouse won the 2015 Best Work Award of the Japan Concrete Institute.

Table-1 Calculation of optimum joint spacing

Concrete Data		Rebar Data	Wall Member			Results		
Strength (N/mm^2)	Drying Shrinkage Rate ($\times10^{-6}$)	Rebar Rate (-)	Thickness (mm)	Length (mm)	Restraint Rate (-)	Average of Cracking Width (mm)	Number of Cracking (-)	Number of Inducing Joints (-)
30	550	0.0089	350	6000	0.2	0.11	1.2	1
					0.3	0.11	2.6	3
					0.4	0.12	3.9	4
					0.5	0.12	5.2	5
				7000	0.2	0.11	1.3	1
					0.3	0.12	2.8	3
					0.4	0.12	4.4	4
					0.5	0.12	5.9	6
				8000	0.2	0.12	1.3	1
					0.3	0.12	3.1	3
					0.4	0.12	4.8	5
					0.5	0.12	6.6	7
				9000	0.2	0.12	1.4	1
					0.3	0.12	3.3	3
					0.4	0.12	5.3	5
					0.5	0.12	7.3	7

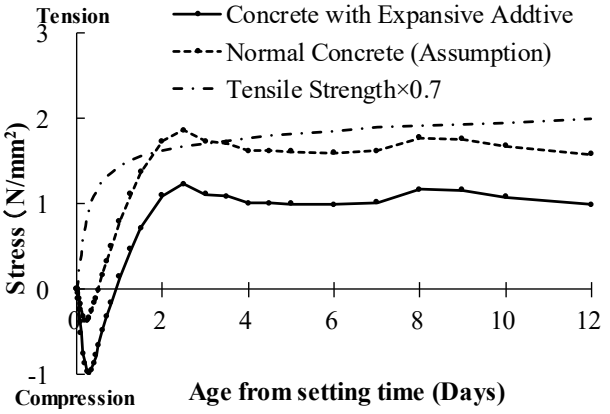

Fig.8 Strain measurement on wall and calculation

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概　要

「久保田」などの銘柄で知られる朝日酒造（株）は，豪雪地帯の新潟県長岡市に位置し，江戸時代から続く日本酒醸造元である。その敷地には，同一の事業者，設計者，施工者が26年の歳月をかけて，長期プロジェクトとして手掛けてきた10棟の建物が建設された。これらの建物群は，主な構造を鉄骨鉄筋コンクリート造とし，外壁仕上げを打放しコンクリート仕上げとしていることから，全体として統一感のある美しい風景を作り出し，また，周囲の里山や田園などの自然環境と融合した景観となっている。

最新の新松籟蔵・新貯蔵棟では，外壁の打放しコンクリートのひび割れ防止・制御を目的として，膨張コンクリートの採用やひび割れ幅予測式による誘発目地間隔の最適化などの技術を導入し，それらの効果の検証を行った。また，豊富な経験に基づく入念な施工がなされており，それらの結果として，竣工から 4 年経過時点でもひび割れはほとんど生じていない。