

Development of a Flexible Head Protection Cap for Bicyclists (Practical Model)

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This study developed a practical model of a flexible head protection cap for bicyclists that combines flexibility and impact attenuation. Although helmet use has been encouraged in Japan since 2023, the wearing rate remains low at approximately 20%. One possible reason is the limited flexibility of conventional helmets, which may reduce comfort and adaptability to diverse head shapes. In previous work, a concept model using polystyrene foam spheres was proposed. However, it lacked retention components, standardized evaluation, and feasibility as a wearable cap. In this study, a practical model was developed by incorporating a retention system with chin straps and a buckle, and by adopting a cap-like outer structure (Figs. 1 and 2). The foam sphere diameter was optimized to 25 mm (Fig. 3) to balance impact attenuation and wearability. Performance was evaluated according to JIS T 8134:2018, including impact attenuation, retention system strength, and roll-off performance. The tests were conducted by a third-party organization. Flexibility was evaluated using a quasi-static load test. The results confirmed that the model satisfied all JIS requirements (Table 1) and exhibited significantly higher flexibility than conventional helmets (Fig. 4), indicating its potential to improve usability and promote helmet use.

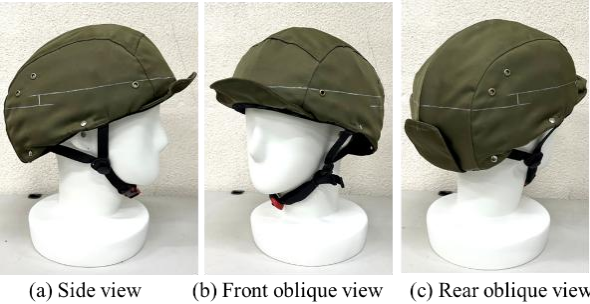


Fig.1 Appearance of Outside of Practical Model

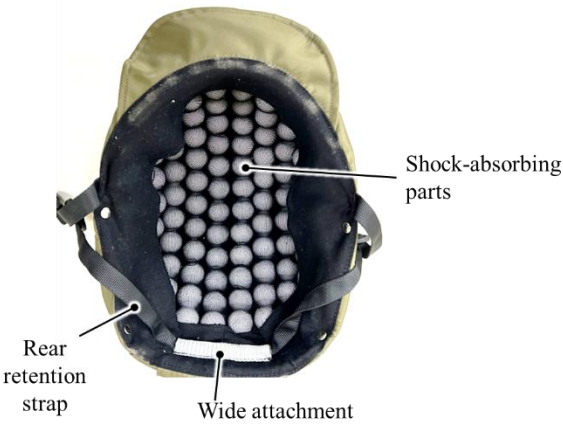


Fig.2 Appearance of Inside of Practical Model

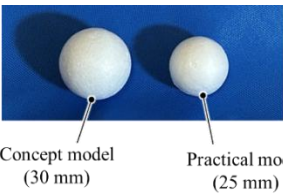


Fig.3 Comparison of Shock-absorbing Parts between Concept Model and Practical Model

Table.1 Test Result of Shock-absorbing Performance

Conditioning	Test Region	Test Type	Peak Acceleration (m/s ²)	Duration (ms)
High-temperature	Frontal	Hemispherical	2,068	1.2
	Occipital	Flat	1,825	1.9
	Left temporal	Hemispherical	1,687	0.8
	Right temporal	Flat	1,986	2.1
Low-temperature	Frontal	Hemispherical	1,896	1.0
	Occipital	Flat	1,914	2.1
	Left temporal	Hemispherical	1,304	0.0
	Right temporal	Flat	2,078	2.2
Immersion	Frontal	Flat	1,854	1.8
	Occipital	Hemispherical	2,101	1.1
	Left temporal	Flat	1,972	2.2
	Right temporal	Hemispherical	1,972	1.0

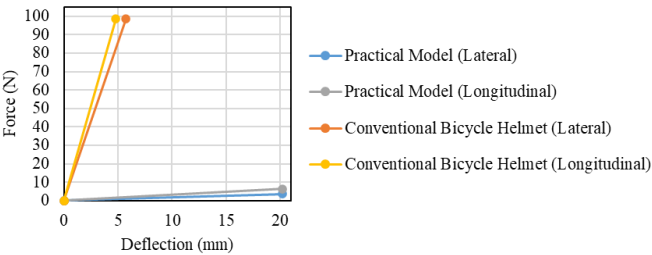


Fig.4 Test Result of Flexibility Performance