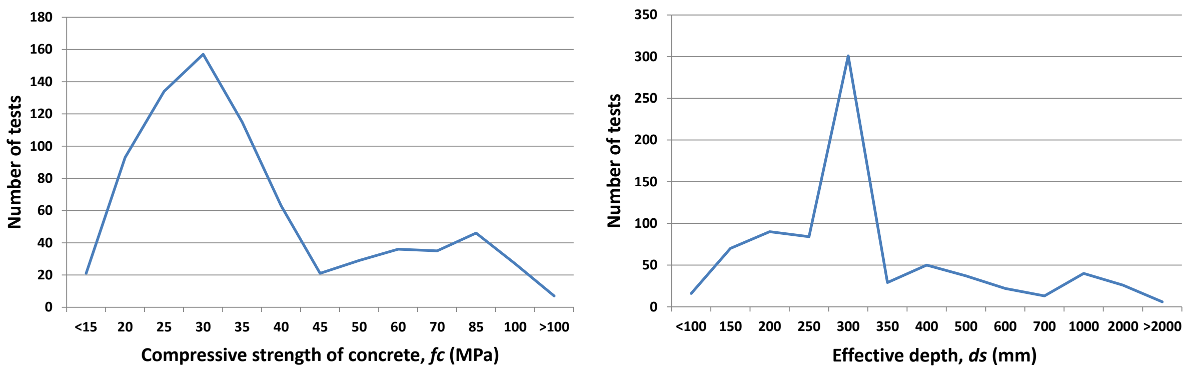
The ACI-DAfStb shear database by Reineck et al. (2013) was used to check the shear strength equations. In order to avoid mistakes, the results were filtered by some criteria: the test results should not include a compressive strength of concrete (f_c') less than 12 MPa, the web width of section (b_w) under 70 mm, and the shear span-depth ratio (a/d) under 2.4. In order to escape the effect of arch action, the span-depth ratio was chosen to be greater 2.4. For the evaluation process, all data was used by comparison. In Fig. 1 there are distributions of the key test variables which were used in experimental results.



(a) Compressive strength of concrete (b) Effective member depth

Fig. 1 – Summary of shear database

3. SNIP CODE FOR RUSSIA AND POST-SOVIET COUNTRIES AND MODIFIED SNIP MODEL

The shear contribution of concrete (V_c) specified in SNiP code is expressed, as follows:

$$V_c = K f_t \frac{d}{a} b_w d \tag{1}$$

where K - strength adjustment factor which is 0.15, f_t is tensile strength of concrete, d is effective member depth of RC member, a is shear span length, and b_w is the width of web concrete. In addition, the $V_{c,\min}$ and $V_{c,\max}$ are specified, as follows:

$$V_{c,\min} = 0.5 f_t b_w d \tag{2}$$

$$V_{c,\max} = 2.5 f_t b_w d \tag{3}$$

A modification factor was derived to consider the size effect, and Eq. (1) can be re-written as follows:

$$V_n = K \frac{d}{a} f_t b_w d = K_d f_t b_w d = 6\sqrt{\frac{1}{d}} f_t b_w d \tag{4}$$

4. COMPARATIVE STUDY

There are six international codes which were chosen in the comparative studies such as SNiP (2012) for the CIS region, ACI318 (2014) for United States, Eurocode2 (2004) for European Union, CSA-A23.3 (2004) for Canada, JSCE (1986) for Japan, and GB 50010 (2010) for China.

4.1. Comparison of shear design methods

Table 1 shows the shear strength ratio (V_{test}/V_{cal}) of 784 test results which were calculated using different design models.

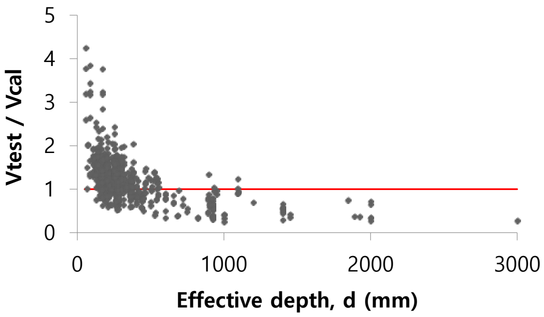
Table 1 –Code assessments for reinforced concrete members

CodeModels	SNiP	ACI318	EC2	CSA-A23.3	GB50010	JSCE	Proposedmodel
Mean	1.20	1.51	1.76	1.36	0.81	1.38	1.67
StandardDeviation	0.47	0.58	0.54	0.35	0.31	0.41	0.50
COV	0.39	0.38	0.30	0.26	0.38	0.30	0.30

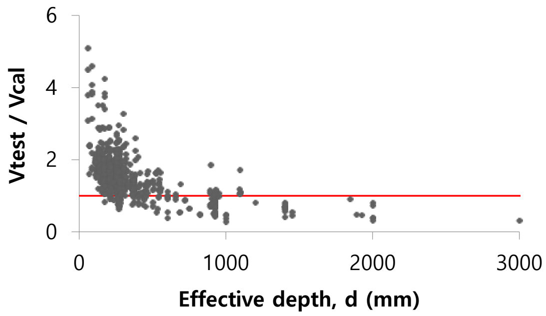
The most accurate prediction among the design codes was that obtained by the CSA-A23.3 code model. In addition, the JSCE code model also showed good results and the GB50010 code model was the least accurate. The model codes such as SNiP, ACI318, and GB50010 showed the more uncertainties.

4.2. Effective member depth

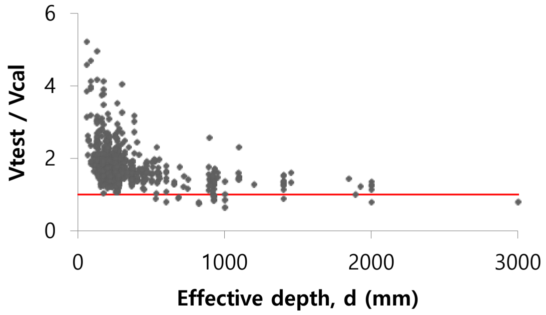
Fig. 2 shows the shear strength ratios (V_{test}/V_{cal}) estimated from the shear design codes. The shear strengths of RC members decreases as the effective member depth (d) increases. The effect of the effective depth (d) is considered in EC2, CSA-A23.3, JSCE, and GB50010, however, apart from CSA-A23.3 the direct effective member depth was chosen by the semi-empirical factors. These factors diverge from $\sqrt{1/d}$ to $\sqrt[4]{1/d}$ for JSCE and GB50010. The EC2, CSA-A23.3, and JSCE code models have large member size showed small scatters for the members with even large member depth. Other models showed a tendency of underestimation as the member depth increases. As shown in Fig. 3, the modified SNiP code well reflect the effective depth, thus, it showed no clear tendency according to the member depth with a conservative strength estimation.



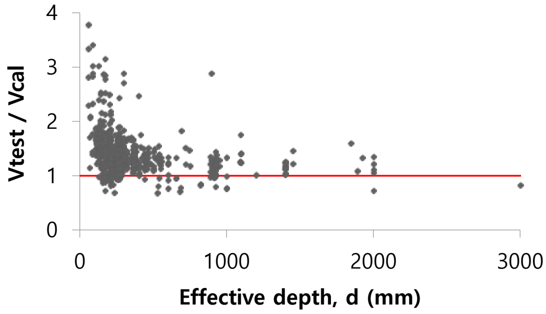
(a) SNiP code



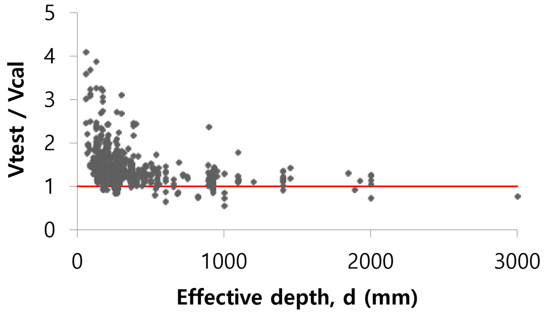
(b) ACI code



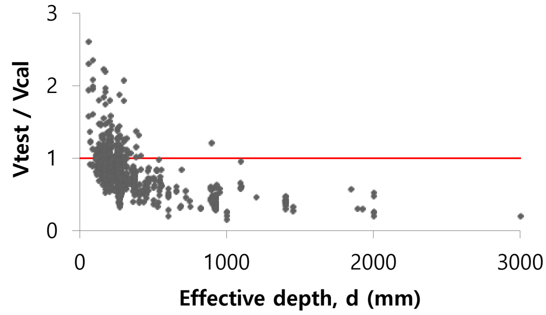
(c) EC2 code



(d) CSA code



(e) JSCE code



(f) GB code

Fig. 2 – Verification of design code against effective member depth

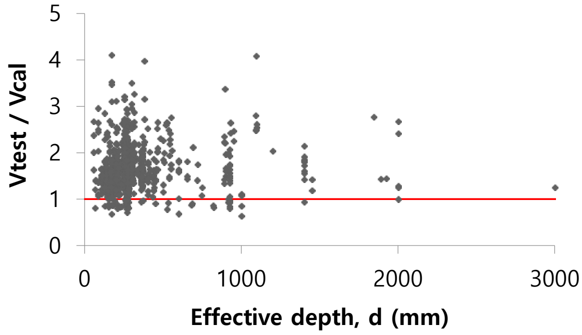


Fig. 3 – Verification of the modified SNiP code against effective member depth

5. CONCLUSION

This study aimed to check the safety and accuracy level of the modified SNiP code model, and it was done by comparing analytical accuracy and safety level with the shear design equations specified in codes such as SNiP (the CIS region), ACI318 (United States), Eurocode2 (European Union), CSA-A23.3 (Canada), JSCE (Japan), and GB 50010 (China).

The modified SNiP code was suggested considering the effective member depth and consequently, this allows more accurate estimation for the shear strength compared to the existing SNiP code model.

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