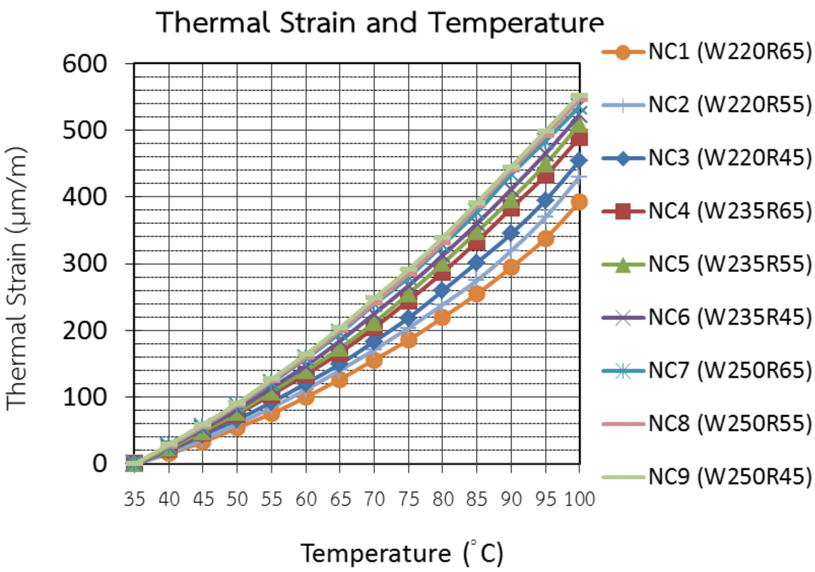
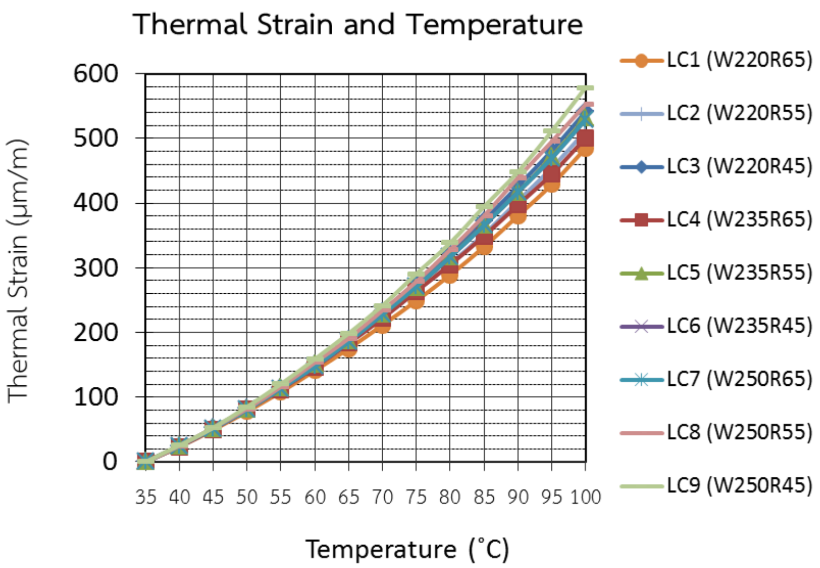
finding was verified by testing the thermal expansion of the crushed stone and the SLA separately. Their thermal strain and coefficient of thermal expansion were found as listed in Table 3. The SLA had higher thermal strain than the crushed stone. This conformed well to the thermal expansion results of the NC and LC aforementioned.



a) Normal concrete (NC)



b) Lightweight concrete (LC)

Fig. 4 Thermal strain of a) normal concrete and b) lightweight concrete developed during the ASTM C 531 test in the range of 35-100°C

Among all mixes, the first three mixes of the NC and LC has lowest amount of cement paste, which was implied that the amount of coarse aggregate was highest. In this situation, the effect of the SLA that caused higher thermal strain in the LC than the NC specimens can be clearly seen. However, compared with cement paste, the thermal strain of these aggregates was low. Thus, in the other six mixes of both NC and LC where the amount of cement paste was increased, the SLA exhibited less influence.

Table 3 Thermal strain and coefficient of thermal expansion of crushed stone and synthetic lightweight aggregate

Type of Aggregates	Thermal Strain (μm/m)	Coefficient of Thermal Expansion (μ/°C)
Crushed Limestone	359	5.13
Synthetic Lightweight Aggregate	394	5.64

4.3 Compressive Strength

Pores in typical lightweight aggregates decrease concrete strength and so do the pores in the synthetic lightweight aggregate (SLA) in this study. As shown in Fig. 5, the compressive strength results of the LC mixes were lower than those of the NC mixes. The strength drop was dependent largely on the amount of the SLA added into the LC mixes.

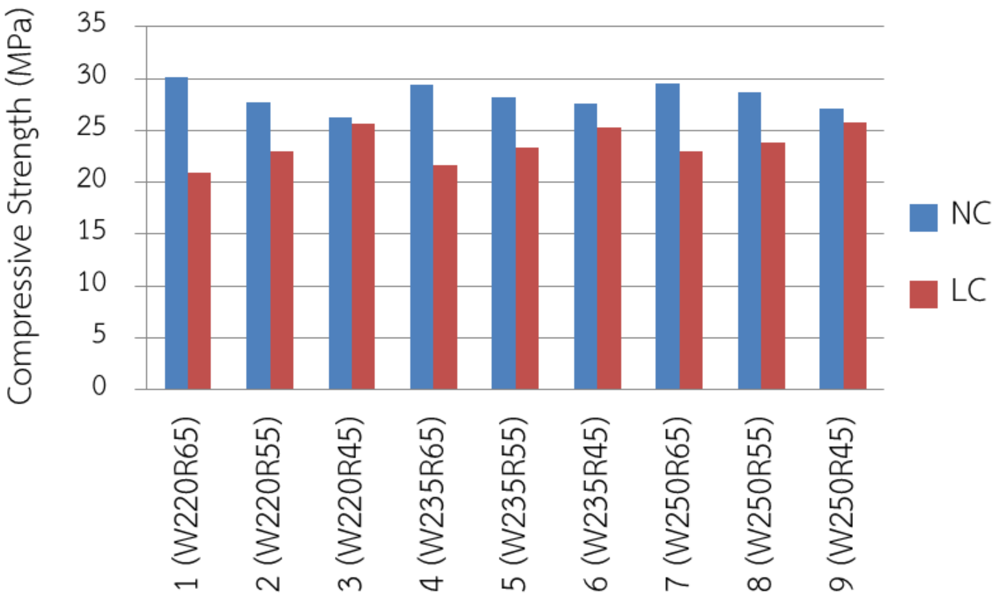


Fig. 5 Compressive strength of normal concrete (NC) and lightweight concrete (LC) tested on 100x100x100 mm cube specimens after moist cured for 28 days

5. CONCLUSIONS

From the comparative study on drying shrinkage and thermal expansion between normal concrete (NC, made of normal aggregate) and lightweight concrete (LC, made of synthetic lightweight aggregate) – by considering the effect of the total aggregate volume (by varying the volume of cement paste) and the course aggregate (by varying the ratio of coarse aggregate to total aggregate) at a constant water-to-cement ratio of 0.55, several conclusions can be drawn as follows.

5.1 Drying Shrinkage

The drying shrinkage of LC was more than that of NC probably because the high porosity of synthetic lightweight aggregate (SLA) lost more water. In general, cement paste is a major part that is shrank. As expected, the test results showed that the higher the content of paste was the higher the shrinkage. When the SLA was introduced into the LC, it caused further contraction. Thus, the SLA content shall be proportional with great care to control drying shrinkage.

5.2 Thermal Expansion

The SLA had higher thermal expansion than the crushed stone. It thus resulted in higher thermal expansion in the LC than the NC specimens. In the NC, the increase of crushed stone reduced the expansion. Conversely in the LC, the increase of SLA increased the expansion. However, both the NC and LC had higher thermal expansion when the cement paste content was increased.

5.3 Compressive Strength

Like other porous lightweight aggregates, the SLA having high porosity decreased the compressive strength of the LC. Therefore, if the SLA will be implemented in lightweight concrete, not only the drying shrinkage is needed to be aware but also the compressive strength.

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