



Fig. 2. Geometrical symmetries and selected initiator elements of Asanoha.

structural total balance. Especially we have proposed assembly rules based on rotation groups. According to this concept, two dimensional hierarchical modular structures are constructed according to two dimensional rotation groups (KISHIMOTO, 2004). Representative cases of first generations are all polyhedrons. In this case, an initial member M is one dimensional element. Using rotation mapping, a closed loop system such as polyhedron is generated. A mapping is characterized by a rotation with $2\pi/n$ [rad] around a center of a symmetric axis. In the same way, second generations are various closed loop systems made of polyhedrons. In the viewpoint of structure engineering, stiffness property of a closed loop system is rather higher. It is easy to construct arbitrary generation closed-loop shapes.

3. Hierarchical Modular Systems with Elements of Japanese Folk Art

3.1. Initiator elements based on geometrical symmetry

In this paper, we apply various initiator elements from folk art into a first module. An “initiator” element means a fundamental minimum element. Initiator elements of folk art are selected based on geometrical symmetry in order to manage connectivity between modules or module groups. Japanese traditional folk art Asanoha, which means flax ornament, is treated for purpose of illustration. Geometrical symmetries of Asanoha are shown in Fig. 2(a) described as *632 in Conway notation (CONWAY and HUSON, 2002) or $p6m$ in crystallographic notation (IUCr, 2006). Figure 2(b) shows two initiator closed elements based on geometrical symmetries. Other elements shown in Fig. 2(c) might be selected, but they can be generated from these two initiator closed elements through