

# 2016 Kumamoto EQ Damage Investigation – Mashiki Town Area

## Preliminary Report

Based on survey carried on May 02, 2016

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**By -**

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# 1 Introduction

In the aftermath of two subsequent big earthquakes in Kumamoto (a foreshock with a magnitude of 6.2 that struck at 21:26 JST on April 14, 2016 at an approximate depth of 11 km, and a magnitude 7.0 mainshock which struck at 01:25 JST on April 16, 2016 at an approximate depth of 10 km), a reconnaissance survey on the damages to structures caused by the earthquakes in the area was carried out on May 2, 2016.

As a single day was not sufficient to cover the entire area affected by the earthquake, focus of the survey was turned towards the possible hardest hit areas based on the geological condition of the area. And, thus, Mashiki town area (south-west of Kumamoto airport) was chosen considering that the area comprises of both the hilly region as well as the flood plain. A walking trip was preferred to get first-hand information on the damage. A total of four areas was visited as a part of the survey during the day's trip, as marked in Figure 1.

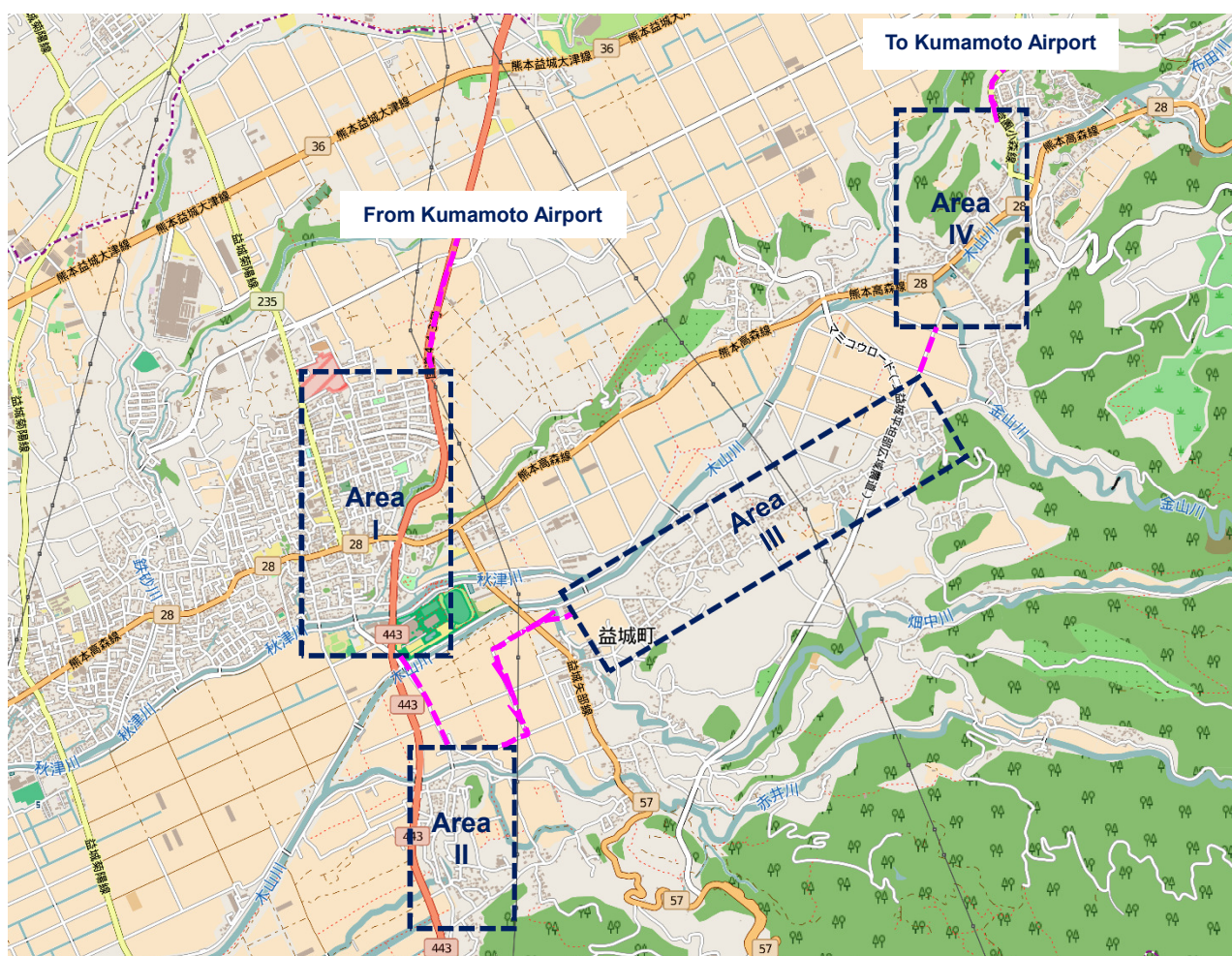


Figure 1: Area map and the surveyed region (*Openstreet – Scale 1:24,000*)

The survey commenced from Tsujinoshiro (辻の城), beginning of the Area I, and ended at Dozono (堂園), end of Area IV, trail of the entire section being as follows:

[A] Tsujinoshiro (辻の城) → [B] Kiyama (木山) → [C] Terasako (寺迫) → [D] Akai (赤井) → [E] Kisaki (木崎) → [F] Fukuhara (福原) → [G] Hatanaka (畑中) → [H] Tanaka (田中) → [I] Hirata (平田) → [J] Ishikawa (石川) → [K] Kamijin (上陳) → [L] Tabaru (田原) → [M] Dozono (堂園)

The graphical representation of the trail is also reflected in Figure 2.



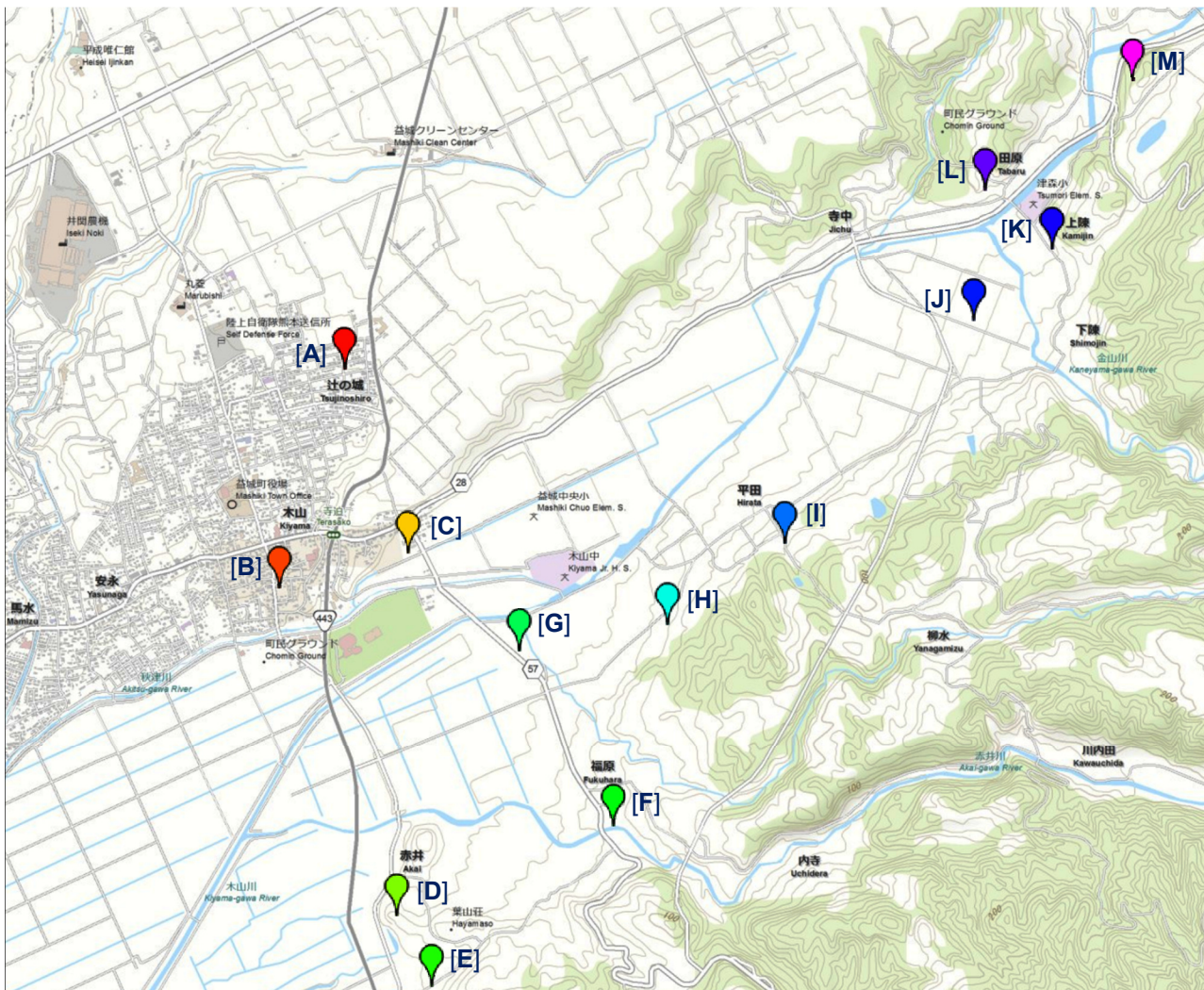


Figure 2: Area map with markers (ESRI – Scale 1:24,000)

It is to be noted that Akai (赤井), Kasaki (木崎), Fukuhara (福原), Hatanaka (畑中), Tanaka (田中), Hirata (平田), Ishikawa (石川), and Kamijin (上陳) lie on the flood plain of the river (i.e., soft deposits). Locations, such as Tsujinoshiro (辻の城), Terasako (寺迫), Kiyama (木山), and Tabaru (田原) lies in the transition between the soft deposit to better soil type (as a sloping surface). The site of Dōzono (堂園) is the landslide area (i.e., hilly part).

## 2 Area I

Surveyed locations defined under Area I (Figure 1) and reproduced in detail under Figure 3 is relatively densely build. The area has an inclined terrain in the north-south direction parallel to route 443 forming the foothill towards the south. Route 28 tentatively marks the bottom of the sloping terrain, forming a plain terrain towards the south from there.

The damage observed during the walk through Area I revealed that roof tiles of almost all the old houses fell during the earthquake. Extensive damages to the pillars and walls of the buildings were noted. There were cases of partial or even complete collapse of walls (*see photo, P-01, under subsection 2.1*). The new houses, on the other hand, showed almost no failure except for some shear cracks appearing on the walls (*P-02*). An example of the contrast between the old house and new house were seen adjacent to each other; old house was almost completely damaged while the new house next to the damaged old house showed almost no sign of damage (*P-03, P-05*). One could



argue here that eventually the strength of the building (as a result of aging) played a key factor for the collapse of structures. Also to be noted is that whether it was an old building or a new, outside equipment (such as heating and/or cooling units) were toppled (P-06). Visible failure of roads on some parts due to the movement of sewer/water lines were seen (P-07). A single case of toppling of a huge stone monument was also seen (P-08). Some cases of visible toppling of buildings (in the form of excessive inclination) due to soil movement towards an existing trench was also observed (P-09, P-10, P-11).



Figure 3: Detailed map of Area I (ESRI – Scale 1:8,500)

As the walking route progressed down slope towards the plain (i.e., towards route 28 as seen in Figure 1), the collapse of both new and old buildings were seen, the slope must possibly playing a greater role as soil tend to move easily towards the foothill (P-12) due to its own gravity effects

Moreover, a case of bridge pier failure was observed, though the vehicle were allowed on the bridge (P-13).

## 2.1 Photos of Area I

Following photos show the status of damage in Area I, in the following order of movement.

[A] Tsujinoshiro (辻の城) → [B] Kiyama (木山) → [C] Terasako (寺迫)





P - 01



P - 02



P - 03



P - 04



P - 05



P - 06











P - 08



P - 09



P - 10









P - 13













### 3 Area II

Surveyed locations defined under Area II (Figure 1) and reproduced in detail under Figure 4 lies in a plain terrain that is the flood plain, Kasaki (木崎) area being close to the foothill in the south direction. The area lies east of Route 443 and continues to form a part of hilly zone on the south side. In the region between Area I and Area II, damages were seen in the bridge pier (*P-14*) as well as failure of road embankments (*P-15*). The electric poles were also inclined (*P-16*). As in the case of Area I, most of the damage suffered in this region is also by the old houses, barn and sheds. Mostly the failure of first floor was seen (*P-17*). However, isolated (not so new house) was seen without any damage (*P-18*). Houses next to an embankment or trench seemed to suffer the most with the visible soil movement (*P-19*). A case of house with a retaining wall next to a trench and without was seen.



The house without the retaining wall suffered a significant damage due to the movement of foundation towards the trench, while the house with retaining wall showed no damage at all (P-19).

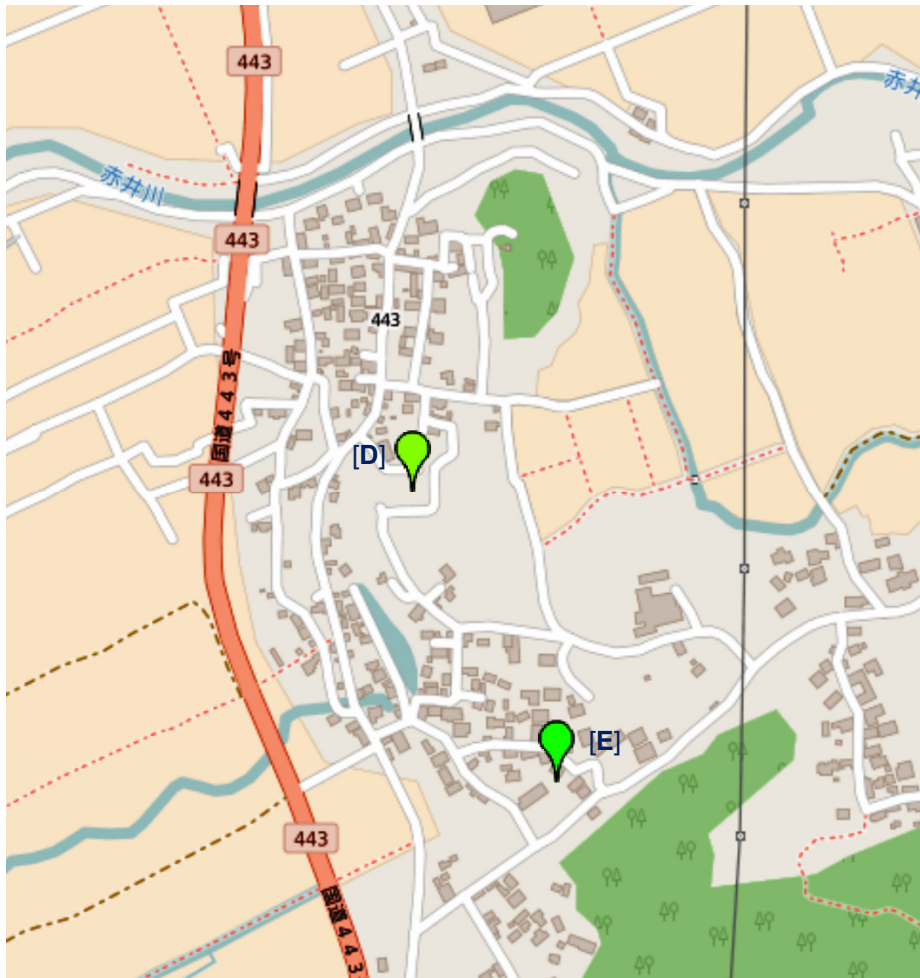


Figure 4: Detailed map of Area II (Openstreet – Scale 1:8,500)

### 3.1 Photos of Area II

Following photos show the status of damage in Area II, in the following order of movement.

[C] Terasako (寺迫) → [D] Akai (赤井) → [E] Kisaki (木崎)











P - 18



P - 19







#### 4 Area III

Surveyed locations defined under Area III (Figure 1) and reproduced in detail under Figure 5 lies in a flood plain and runs approximately parallel to the Kiyama river (木山川 – see Figure 5). The alluvial deposits extends towards the south-west side up to the bottom of the hill. The area comprises of both the old settlement, with old and some newly built houses, and a completely new settlement. The old houses in these area suffered inclinations, roof failure, and in some cases the failure of ground floor. The new residential area in this area, on the other hand, shows almost no sign of damage at all (*P-20*, *P-21*, *P-22*), once again showing that strength of structures might be the key. One the other hand, these new buildings are presumed to be built based on new seismic design code, thus, showing higher resistance against earthquake shaking.

A short section of distinct surface fault was visible both crossing the rice field (*P-23*) and a road (*P-24*). Additionally, complete collapse of a concrete bridge over the Kiyama river (木山川) was also seen (*P-25*). Vertical cracks was also seen on the surface of embankment.



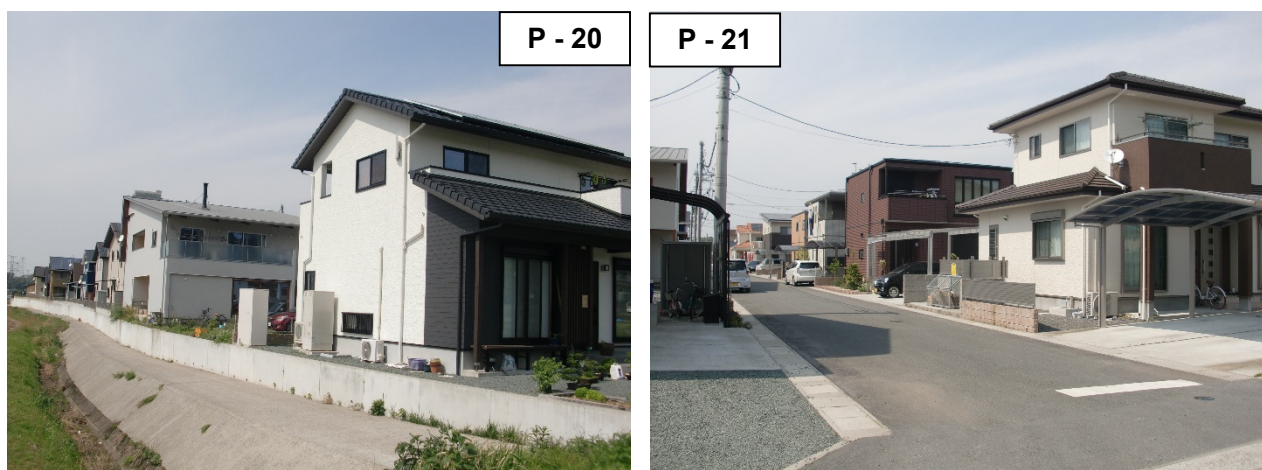


Figure 5: Detailed map of Area III (Openstreet – Scale 1:14,000)

#### 4.1 Photos of Area III

Following photos show the status of damage in Area III, in the following order of movement.

[E] Kisasi (木崎) → [F] Fukuhara (福原) → [G] Hatanaka (畑中) → [H] Tanaka (田中) → [I] Hirata (平田) → [J] Ishikawa (石川)



















## 5 Area IV

Surveyed locations defined under Area IV (Figure 1) and reproduced in detail under Figure 6 lies in hilly region on either side of the Kiyama river (木山川 – see Figure 1) and the last area to be surveyed. Old houses and barns showed damages, while relatively new houses were found to be in good shape, though cracks propagating through the walls could be seen. A surface fault was seen propagating towards east direction (*P-25*, *P-26*, *P-27*) through rice fields (originating in Ishikawa (石川) area and straight through a house (*P-29*, *P-30*), crossing Kaneyamaga river (金山川) in between (*P-28*). The suffered house show a significant damage due to the fault passing through the house. In Tabaru (田原) region, which is located on the hilly terrain on the north side of the flooding plain, old houses were seen with inclination. Collapsed retaining walls were seen (*P-31*).

As for the Dozono (堂園) region, the area was surveyed from across the river (i.e., from Tabaru (田原)). A massive landside blocking the road could be seen (*P-32*).



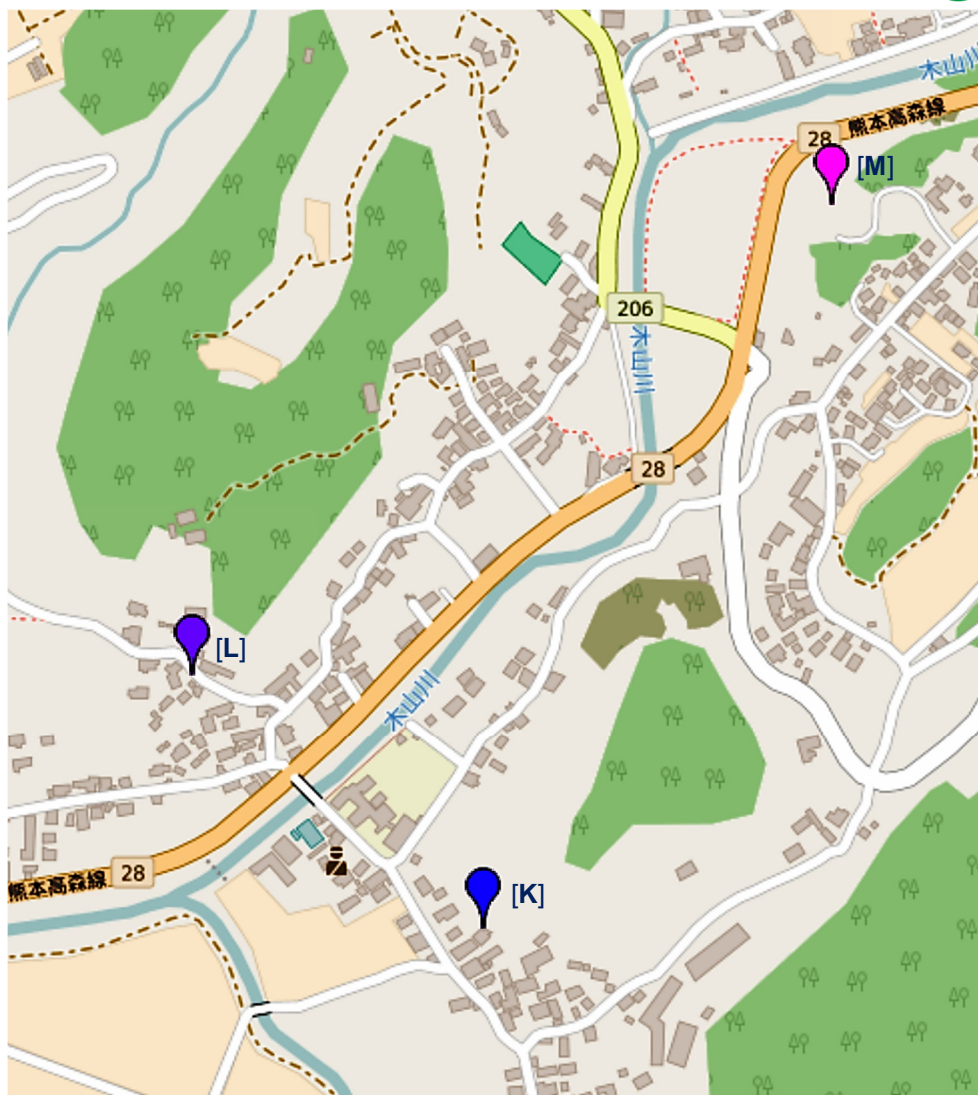


Figure 6: Detailed map of Area IV (Openstreet – Scale 1:8,000)

### 5.1 Photos of Area III

Following photos show the status of damage in Area IV, in the following order of movement.

[J] Ishikawa (石川) → [K] Kamijin (上陳) → [L] Tabaru (田原) → [M] Dozono (堂園)







P - 25



P - 26



P - 27



P - 28



P - 29



P - 30



P - 29



P - 30





P - 31



P - 32

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